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For Examiner's Use
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Examiner's Initials
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**academic potential test  
for future A-level students 2020**

**Time allowed: 90 minutes**

Instructions:

- Use black ink or black ball-point pen.
- Answer all questions.
- You are allowed to use a calculator.
- Unless otherwise stated in a question, all numerical answers must be given either exactly or correct to 3 significant figures.

Information:

- The test consists of a few sections.
- Note that the last section is for students who consider doing Further Mathematics in A-levels.

Questions	Mark
1-4	/17
5-7	/10
8-10	/7
11-14	/13
15-17	/8
(*)18-24	/18
<b>total Standard</b>	<b>/55</b>
<b>total Advanced</b>	<b>/73</b>
<b>SL score</b>	
<b>AL score</b>	



## ARITHMETIC & ALGEBRA

**Q1. [8 marks]**

Express in terms of  $a$ . Give your answer in exact form.

**Q1.1**  $\sqrt[3]{a^{-2}a^8}$


**Q1.2**  $\sqrt{a^6 \times \left(1\frac{1}{3}\right)^{-2}}$


**Q1.3**  $\left(\frac{1}{4}a^{-2}\right)^3 \div \left(\frac{1}{2}a^{-3}\right)^4$


**Q1.4**  $\frac{(2a)^8(4a^2)^7}{(16a^3)^8 \div (-8a)^3}$


**Q2. [2 marks]**

Find the number whose 22% is equal 75. Give your answer to 2 decimal places.




**Q3. [3 marks]**

Rationalize the denominator of the following fractions. Show your workings fully.

**Q3.1**  $\frac{\sqrt{8}-4}{\sqrt{2}}$


**Q3.2**  $\frac{2a\sqrt{3}+a}{\sqrt{3}-2}$


**Q4. [4 marks]**

Expand and leave the answer in simplest form.

**Q4.1**  $(4x + \frac{1}{2})^2$


**Q4.2**  $(a - b + ab)^2$


**Q4.3**  $(a\sqrt{2} - 3)(a\sqrt{8} + 1) - (2a)(2a - 2\sqrt{2})$




## STATISTICS & PROBABILITY

**Q5. [3 marks]**

A fair cubic dice and a fair coin are tossed once. On one side of the coin there is a number 1 and on the other side there is a number 2. What is the probability that the sum of outcomes is larger than 4?


**Q6. [4 marks]**

Consider four **different** whole numbers that have the following properties:

- their range is 6,
- their median is 7,
- their mean is 7.5.

Find the numbers.


**Q7. [3 marks]**

In a group of 20 students 14 learn French, 9 learn German and 2 do not learn any of the two languages. A student is chosen at random from the group. What is the probability that he learns both French and German?




## EQUATION OF A LINE

**Q8. [2 marks]**

Consider the points  $(-3, 4)$  and  $(1, -3)$ .

**Q8.1** Find the gradient of the line passing through the points.

Give your answer as an exact fraction.


**Q8.2** Find the distance between the points.


**Q9. [3 marks]**

Find the equation of a line perpendicular to  $y = 1.5x + 2$  and passing through point  $(6, -1)$ .

Give your answer in the form  $Ax + By + C = 0$ , where  $A$ ,  $B$  and  $C$  are integers.


**Q10. [2 marks]**

Find the area of the triangle bounded by the line  $y = \frac{2}{3}x - 3$  and the coordinate axes.




## EQUATIONS & INEQUALITIES

**Q11. [3 marks]**

Find the set of common solutions of the following inequalities.

$$7 - 2x > 0 \quad \text{and} \quad 5x + 10 \geq 0 \quad \text{and} \quad |x| < 1$$


**Q12. [7 marks]**

Solve the equations and inequalities. Give all answers in simplest form.

**Q12.1**  $x^2 + 7x - 8 = 0$


**Q12.2**  $\frac{x-1}{3} = \frac{2}{x-1}$


**Q12.3**  $x + \frac{6}{x} = 7$




**Q12.4**  $x^2 = 5x$


**Q12.5**  $|x + 1| = 3$


**Q12.6**  $x^2 - 2x < 3$


**Q13.** [1 marks]

Make  $r$  the subject of the formula  $F = G\frac{m_1m_2}{r^2}$ .


**Q14.** [2 marks]

Solve the following equations simultaneously.

$$5x + 4y = 6 \quad \text{and} \quad 3x - 2y = 8$$




## TRIGONOMETRY

You may like to use the cosine rule in this section:  $c^2 = a^2 + b^2 - 2ab \cos C$ .

**Q15. [3 marks]**

In triangle  $ABC$  the sides  $AB$  and  $BC$  are 6 and 4 respectively. The angle at  $A$  is  $35^\circ$ . Find the measure of the angle  $C$ .


**Q16. [2 marks]**

Find the measure of the smallest angle in the triangle with sides 3, 5 and 7.






**Q17. [3 marks]**

**Q17.1** Find the obtuse angle  $B$  such that  $\sin B = \sin 40^\circ$ .


**Q17.2** Find an angle  $C$  such that  $\cos C = -\sin C$ .


**Q17.3**  $D$  is an acute angle ( $0^\circ < D < 90^\circ$ ). Find the exact value of  $\cos D$  if  $\sin D = \frac{2}{3}$ .

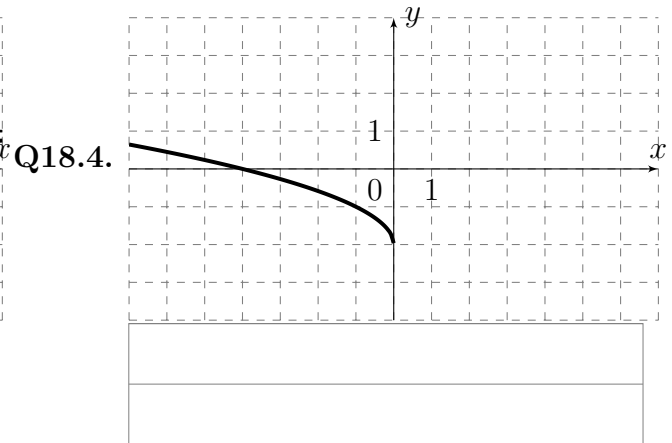
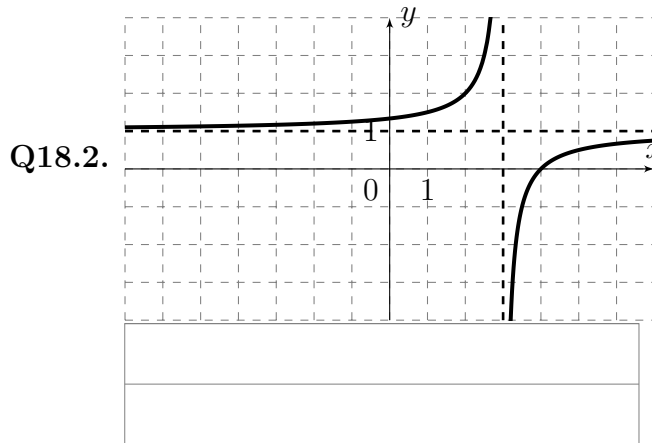
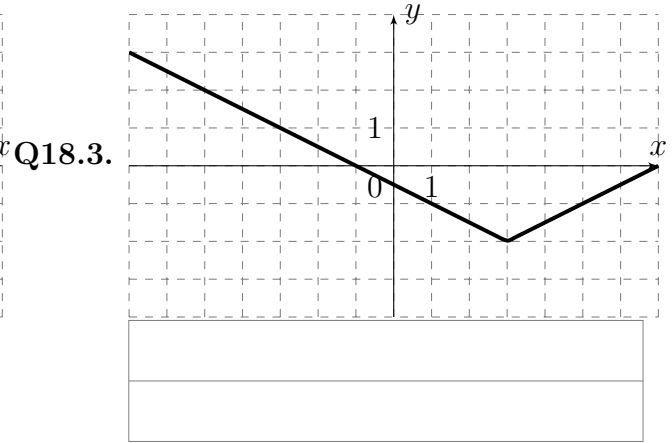
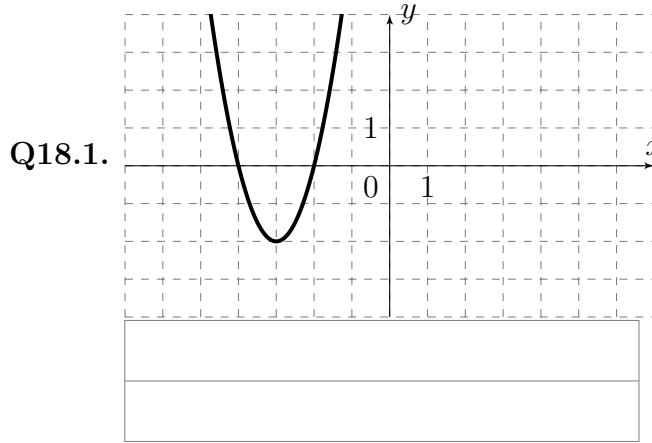

*For candidates who consider doing A Level Mathematics  
but not Further Mathematics the exam finishes here.  
An additional section for students considering  
Further Mathematics starts on the next page.*



### ADVANCED PART

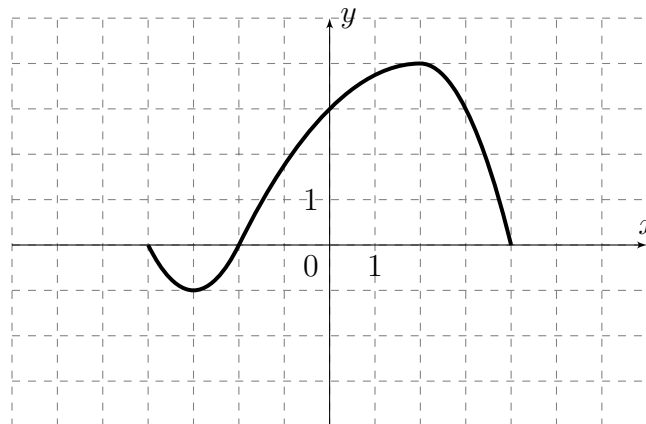
Q18. [4 marks]

Write down an equation of each of the curves shown below.



Q19. [3 marks]

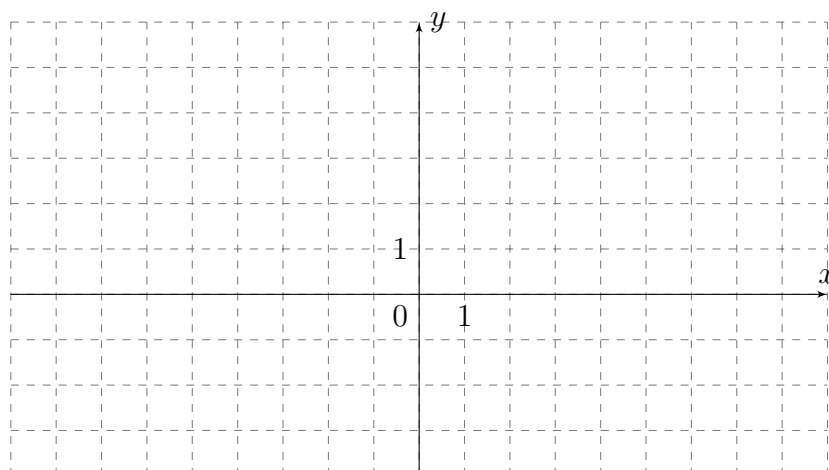
Consider the graph of the function  $y = f(x)$  shown below.



In the diagrams on the next page sketch the graphs of the curves with given equations.

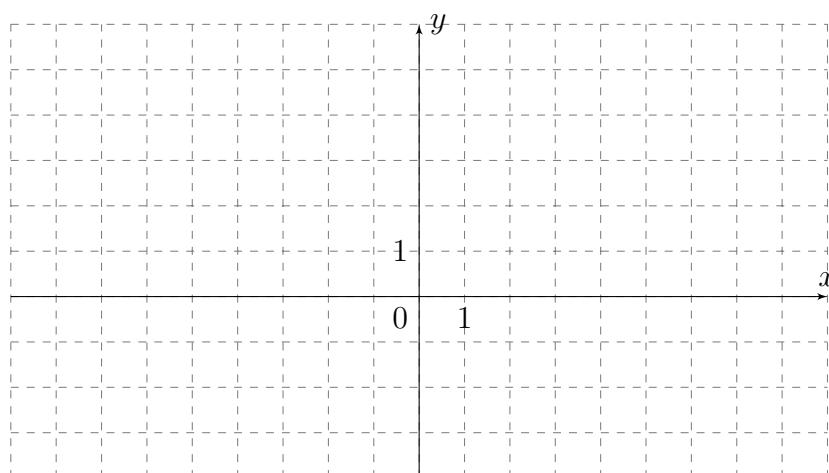


Q19.1.



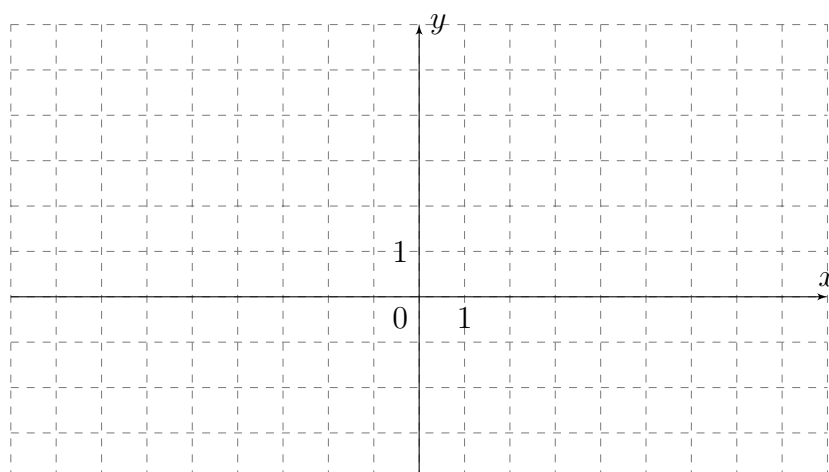
$$y = \frac{1}{2}f(x)$$

Q19.2.



$$y = f(2x)$$

Q19.3.



$$y = f(x + 2)$$



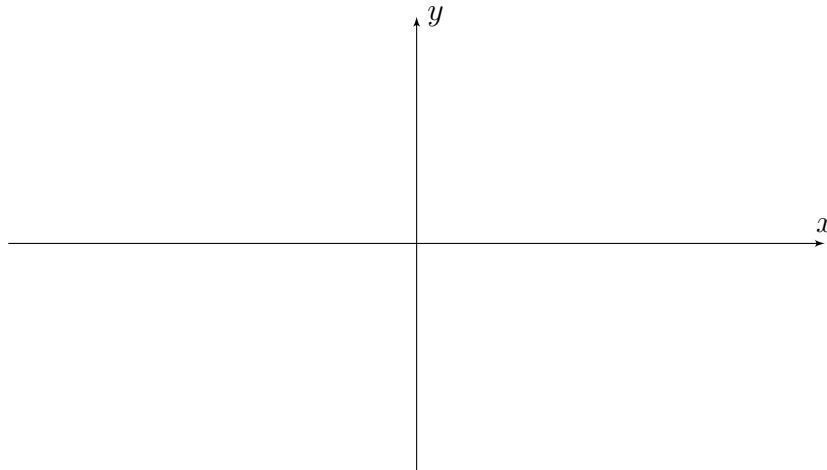
**Q20. [2 marks]**

Sketch the graph of

$$y = x^2(x - 1)(x - 2)$$

and hence or otherwise solve the inequality

$$x^2(x - 1)(x - 2) < 0.$$




**Q21. [3 marks]**

Which of the numbers is larger?

**Q21.1.**  $\log_{(a^2)}(a^3)$  or  $\log_{(a^3)}(a^2)$


**Q21.2.**  $\left(\frac{1}{2}\right)^x$  or  $\left(\frac{1}{2}\right)^{x+1}$


**Q21.3.**  $\log_a b$  or  $\log_{(2a)} b$  when  $a > 1$




**Q22. [1 marks]**

Find the distance of the centre of the circle  $(x + 6)^2 + (y - 8)^2 = 11$  from the origin.


**Q23. [3 marks]**

Find the coordinates of the points where the circle  $(x - 2)^2 + (y + 8)^2 = 100$  intersects the  $x$ -axis.


**Q24. [2 marks]**

What is the constant term of the expansion  $(x + \frac{2}{x})^6$ ?