GCHQ

Worksheets

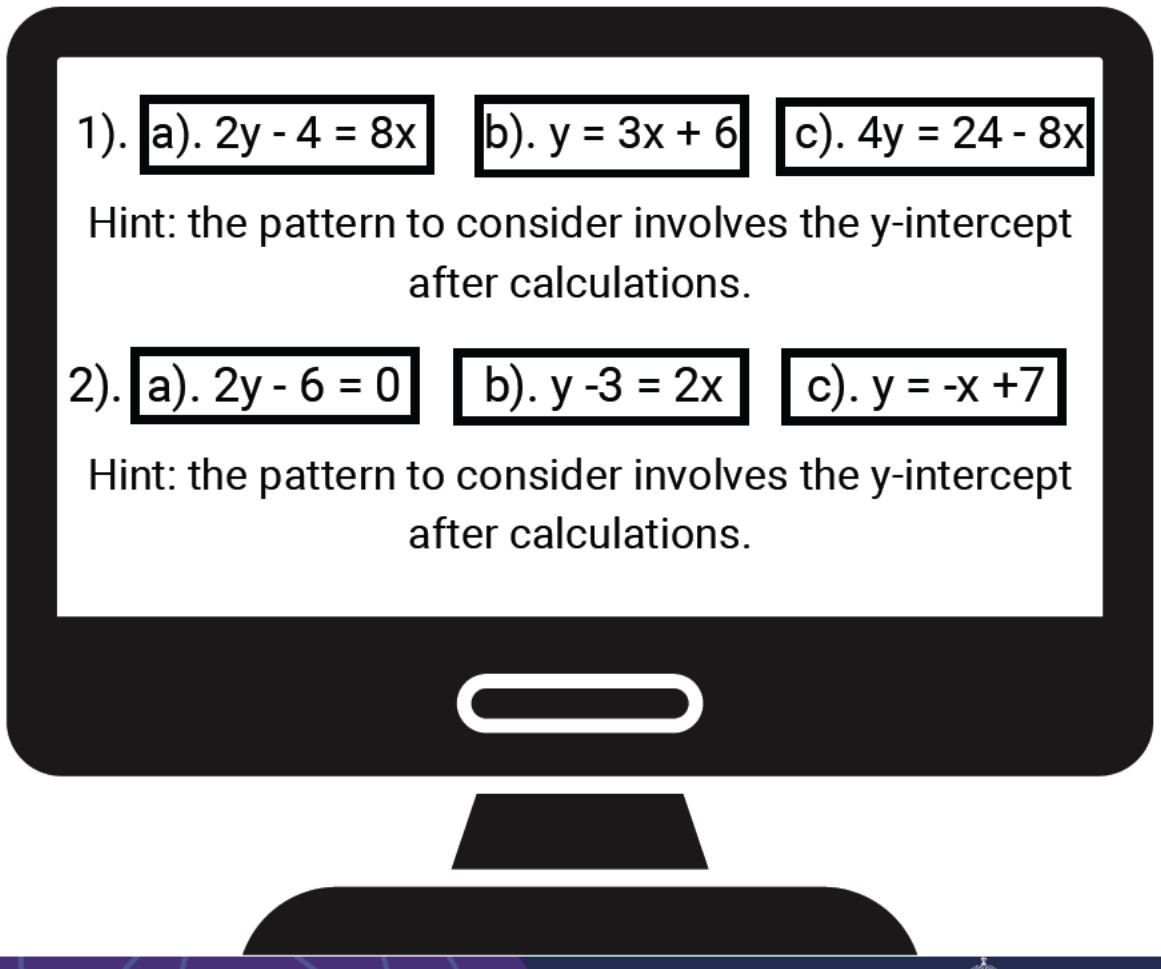
Maths and GCHQ

Maths and GCHQ

Mathematics is deeply embedded within cybersecurity and provides tools to secure systems, analyse data, protect sensitive information and detect anomalies in data. During the covid-19 pandemic, the National Cyber Security Centre (NCSC) which is part of GCHQ, played a vital role ensuring the NHS and more widely, the Health sector, kept their systems secure and protected from cyber threats. If, for example, the NHS' data was at risk, one way threats to cybersecurity can be identified is by using linear algebra to analyse patterns in data and detect deviations in data, which can signify a cyber threat. Especially when dealing with large data sets or encrypted messages.

Help the NCSC, a vital part of GCHQ detect anomalies in a banks systems to secure it from cyber threats. You will need to look at the patterns for each row of linear equations and determine which equation does not belong in the data row.

Have a practice go using the the linear equations below, we have already detected the anomalies from these equations as they were from a previous cyber threat. The new mission and information will be on the next page once you successfully showcase your skills here. Time is precious when working with cyber threats, so you only have 10 minutes to find the anomalies here.



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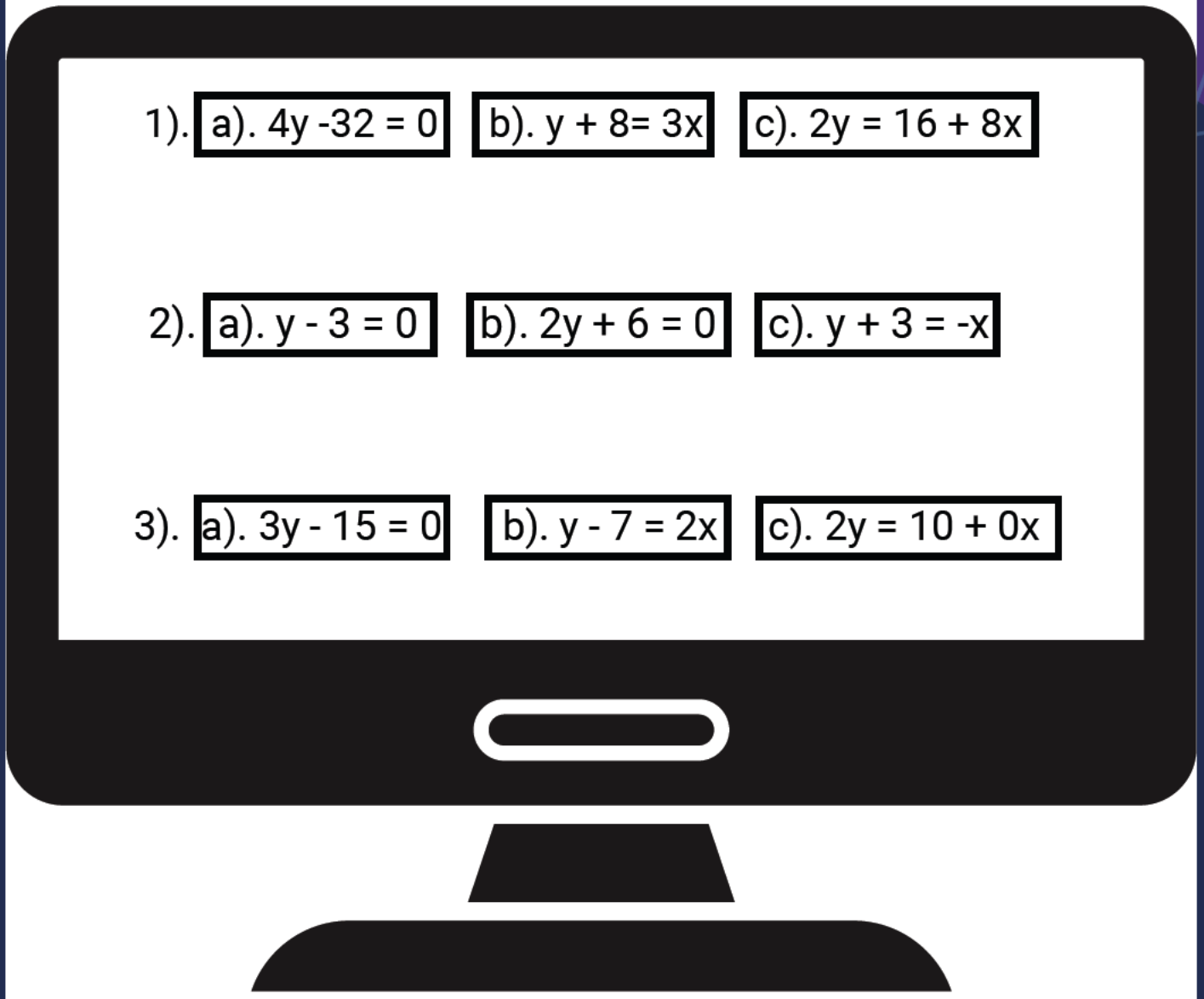
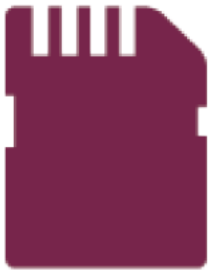
NCSC have been tasked with a new mission. They received a call from a well known bank that needs their new security system secured after a cyber threat. You only have 30 minutes to check the systems codes and make sure it is secure, otherwise it could put important data at risk.
You will need to look at the patterns for each row of linear equations and determine which equation does not belong in the data row. Show your working out. **Circle** the one that does not belong. Each row will give you a clue for the master data chip password, needed at the end so you can unlock a top secret task and safely secure the data. Hurry!

1). a). $4y - 32 = 0$ b). $y + 8 = 3x$ c). $2y = 16 + 8x$

2). a). $y - 3 = 0$ b). $2y + 6 = 0$ c). $y + 3 = -x$

3). a). $3y - 15 = 0$ b). $y - 7 = 2x$ c). $2y = 10 + 0x$





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Extension Task

You have unlocked the top secret GCHQ task, well done! This is the final task you will need to complete, which will provide extra security to the banks security system.
You will need to watch the GCHQ videos (provided by your teacher) and answer the questions below. Listen or read the transcript 'Life in the Mathematics & Cryptography team' to complete question 1. Then listen or read the transcript of the 4 speakers from the GCHQ team to answer questions 2-14.

At GCHQ mathematicians shape everything from cyber security to mobile communications. They use a variety of techniques across many disciplines to solve complex problems. Using specialised architecture, they write highly optimised algorithms and get the most out of computing.

1). Using the **first audio or transcript,** finish this sentence.

'This is real maths, ____ _____ ____ ____.

2). Look at the job roles and videos/transcripts.
Name 2 jobs mentioned at GCHQ that use maths skills.

a).
b).

Audio 1

3). What 3 steps does the person in the audio mention being part of the application process?

_____

_____

4). What surprised the speaker most when they first started?

_____

_____

Audio 2

5). What attracted the speaker to a role at GCHQ?

_____

_____

_____

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6). What does the speaker say was more important than them answering every question correctly in the application test?

_____

_____

7). What does the speaker say is the basis of how others view (judge) each other at GCHQ?

_____

_____

Audio 3

8). What does the speaker say their job includes?

_____

_____

_____

9). What training programmes did they do when they started at GCHQ?

_____

_____

10). When is it okay to discuss your job at GCHQ and what you are doing?

_____

_____

11). What attracted the speaker to the job?

_____

_____

_____

12). What did the speaker enjoy most at GCHQ?

_____

_____

Audio 4

13). What new skills did the speaker acquire when they joined GCHQ?

_____

_____

_____

14). What does they speaker say is another quality that is more important than being willing to learn?

_____

_____

_____

Answer sheet

Practice questions

1). Odd one out is **Equation 1A.** It has a different y-intercept of 2 or (0,2), compared to B and C which both have a y-intercept of 6 or (0,6).

Example of working out

Calculations may involve equations to be rearranged into the form of y=mx+c, where m represents the slope. Each equation, as required, can be rewritten with this equation in mind. Then the y-intercepts can be compared.

Equation 1a: 2y-4=8x

2y-4=8x

Add 4 to both sides to isolate the y.
2y=8x+4

Divide every term by 2, to calculate y.

$$y= \frac{8x}{2} + \frac{4}{2}$$

y=4x+2

The equation is now in the form of y=mx+c
The y intercept (c) is 2.
Therefore, the y-intercept is (0,2).

Equation 1b: y=3x+6

The equation is already in the form of y=mx+c.

The y-intercept (c) is 6.
Therefore, the y-intercept is (0,6).

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Answer sheet

Equation 1c: 4y=24-8x

4y=24-8x

Rearrange the equation, to get y by itself.
4y=-8x+24

Divide every term by 4, to calculate y.

$$y = \frac{-8x}{4} + \frac{24}{4}$$

y=-2x+6

The equation is now in the form of y=mx+c
The y intercept (c) is 6.
Therefore, the y-intercept is (0,6).

Overall:

Equation 1a: 2y-4=8x - y-intercept: c=2 or (0,2) (Odd one out)

Equation 1b: y=3x+6 - y-intercept: c=6 or (0,6)

Equation 1c: 4y=24-8x - y-intercept: c=6 or (0,6)

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Answer sheet

2). Odd one out is **Equation 2C**. It has a different y-intercept of 7 or (0,7), compared to A and B which both have a y-intercept of 3 or (0,3).

Example of working out

Equation 2a: 2y-6=0

2y-6=0

Add 6 to both sides.
2y=6

Divide both sides by 2, to calculate y.

$$y = \frac{6}{2}$$

y=3

The equation is now in the form of y=mx+c
The y intercept (c) is 3.
Therefore, the y-intercept is (0,3).

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Answer sheet

Equation 2b: y-3=2x

y-3=2x

Add 3 to both sides, to isolate y.
y=2x+3

The equation is now in the form of y=mx+c
The y intercept (c) is 3.
Therefore, the y-intercept is (0,3).

Equation 2c: y=-x+7

The equation is already in the form of y=mx+c.

The y-intercept (c) is 7.
Therefore, the y-intercept is (0,7)

Overall:

Equation 2a: 2y-6=0 - y-intercept: c=3 or (0,3)

Equation 2b: y-3=2x - y-intercept: c=3 or (0,3)

Equation 2c: y=-x+7 - y-intercept: c=7 or (0,7) (Odd one out)

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Answer sheet

Task

1). Odd one out is **Equation 1B.** It has a different y-intercept of -8 or (0,-8), compared to A and C which both have a y-intercept of 8 or (0,8).

Hint to provide students (if needed) - Pattern involves the y intercept. Be mindful of the negative and positive values.

Example of working out

Calculations may involve equations to be rearranged into the form of y=mx+c, where m represents the slope. Each equation, as required, can be rewritten with this equation in mind. Then the y-intercepts can be compared.

Equation 1a: 4y-32=0

4y-32=0

Add 32 to both sides to isolate the y.
4y=32

Divide both sides by 4, to calculate y.

$y = \frac{32}{4}$

y=8

The equation is now in the form of y=mx+c
The y intercept (c) is 8.
Therefore, the y-intercept is (0,8).

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Answer sheet

Equation 1b: y+8=3x

y+8=3x

Subtract 8 from both sides to isolate the y.
y=3x-8

The equation is now in the form of y=mx+c
The y intercept (c) is -8.
Therefore, the y-intercept is (0,-8).

Equation 1c: 2y=16+8x

2y=16+8x

Rearrange equation and subtract 8x from both sides
2y = 8x+16

Divide each term by 2, to isolate y.

$$y=\frac{8x}{2}+\frac{16}{2}$$

y=4x+8

The equation is now in the form of y=mx+c
The y intercept (c) is 8.
Therefore, the y-intercept is (0,8).

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Overall:

Equation 1a: 4y-32=0 - y-intercept: c=8 or (0,8)

Equation 1b: y+8=3x - y-intercept: c=-8 or (0,-8) (Odd one out)

Equation 1c: 2y=16+8x - y-intercept: c=8 or (0,8)

GCHQ

Answer sheet

Task

2). Odd one out is **Equation 2A**. It has a different y-intercept of 3 or (0,3), compared to B and C which both have a y-intercept of -3 or (0,-3).

Hint to provide students (if needed) - Pattern involves the y intercept. Be mindful of the negative and positive values.

Example of working out

Calculations may involve equations to be rearranged into the form of y=mx+c, where m represents the slope. Each equation, as required, can be rewritten with this equation in mind. Then the y-intercepts can be compared.

Equation 2a: y-3=0

y-3=0

Add 3 to both sides to isolate the y.
y=3

The equation is now in the form of y=mx+c
The y intercept (c) is 3.
Therefore, the y-intercept is (0,3).

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Answer sheet

Equation 2b: 2y+6=0

2y+6=0

Subtract 6 from both sides to isolate the term containing y.
2y=-6

Divide each term by 2.

$y= \frac{-6}{2}$

y=-3

The equation is now in the form of y=mx+c
The y intercept (c) is -3.
Therefore, the y-intercept is (0,-3).

Equation 2c: y+3=-x

y+3=-x

Add 3 to both sides to isolate the y.
y=-x-3

The equation is now in the form of y=mx+c
The y intercept (c) is -3.
Therefore, the y-intercept is (0,-3).

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Answer sheet

Overall:

Equation 2a: y-3=0 - y-intercept: c=3 or (0,3) (Odd one out)

Equation 2b: 2y+6=0 - y-intercept: c=-3 or (0,-3)

Equation 2c: y+3=-x - y-intercept: c=-3 or (0,-3)

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Answer sheet

Task

3). Odd one out is **Equation 3B**. It has a different y-intercept of 7 or (0,7), compared to A and C which both have a y-intercept of 5 or (0,5).

Hint to provide students (if needed) - Pattern involves the y intercept. Are all equations in the y=mx+c format?

Example of working out

Calculations may involve equations to be rearranged into the form of y=mx+c, where m represents the slope. Each equation, as required, can be rewritten with this equation in mind. Then the y-intercepts can be compared.

Equation 3a: 3y-15=0

3y-15=0

Add 15 to both sides to isolate the y.
3y=15

Divide both sides by 3, to identify y.

$y = \frac{15}{3}$

y=5

The equation is now in the form of y=mx+c
The y intercept (c) is 5.
Therefore, the y-intercept is (0,5).

GCHQ

Answer sheet

Equation 3b: y-7=2x

y-7=2x

Add 7 to both sides.
y=2x+7

The equation is now in the form of y=mx+c
The y intercept (c) is 7.
Therefore, the y-intercept is (0,7).

Equation 3c: 2y=10+0x

2y=10+0x

Rearrange the equation.
Since 0x does not affect the equation. this can be rewritten as:
2y=10

Divide every term by 2, to isolate y.

$y=\frac{10}{2}$

y=5

The equation is now in the form of y=mx+c
The y intercept (c) is 5.
Therefore, the y-intercept is (0,5).

GCHQ

Answer sheet

Overall:

Equation 3a: 3y-15=0 - y-intercept: c=5 or (0,5)

Equation 3b: y-7=2x - y-intercept: c=7 or (0,7) (Odd one out)

Equation 3c: 2y=10+0x - y-intercept: c=5 or (0,5)

If the code is correct, your students will have correctly circled all of the odd equations.
Code ->> -8,3,7

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Answer sheet - Extension Task

1). 'This is real maths, **to solve real problems'.**

2). a). Mathematician b). Cryptographer OR Cryptomaths Researcher

Audio 1

3). Online form, interview, vetting process (to make sure you're not a security threat).

4). Everyone, regardless of how high they are in the organisation, is so approachable and happy to help you out.

Audio 2

5). They were attracted by the prospect of doing maths, and not having to go into accounting or teaching.

6). It was more about seeing how they worked than whether or not they answered the questions correctly.

7). You're not judged on who you are, how old you are or where you went to university, but by the quality of the work that you do.

Audio 3

8). Their job includes using mathematics like linear algebra, group theory and statistics.

9). The moment you join you do a Maths Development Programme, where all the new mathematicians take part in a four week long course covering areas like algorithms and statistics.

10). Once you're inside the building everyone's happy to talk to you about what they're doing and sometimes they even ask for your input.

Answer sheet - Extension Task

11). They were looking for a place where they could use the maths they'd learnt, but outside of a university environment. And they really liked the idea of being part of a place that does vitally important work.

12). Being part of a community and working with like-minded people. On one hand, you've got graduates who have come straight into the organisation and then on the other, you've got some of the best mathematicians giving really inspiring talks.

Audio 4

13).They are now a competent programmer because they went through lot of training and programming practice.

14). Be very persistent.

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