Bank of England Museum

THE FUTURE OF MONEY

The Future of Money

PACK 4

Education, Environment, Sustainability

An education resource for students aged 11-14.

Contents

About the Future of Money exhibition

This resource collection is designed to accompany The Future of Money exhibition at the Bank of England Museum. The resources explore the links between the exhibition and a range of mathematical ideas, using exhibition objects and themes as a starting point for discussion and mathematical problem-solving. These activities will work in the classroom or at home and are designed for students aged 11-14.

The resources contain supporting notes for teachers, images from the exhibition and student activity sheets. There are five resource packs, each focusing on a different exhibition theme:

Pack 1: What is Money?

Topics covered include: compound measures; units of measurement; problem solving; probability

Pack 2: Futureproofing Today's Systems

Topics include: data collection and questionnaires; analysing data; bar charts; pie charts.

Pack 3: Future Methods of Payment

Topics include: prime numbers and their properties; divisibility rules; sampling methods; calculating percentages

Pack 4: Education, Environment, Sustainability

Topics include: 3D shapes; adding, subtracting and dividing with decimals; problem solving

Pack 5: Data and Privacy

Topics include: sequences and patterns; problem solving; inverse operations; division with remainders

Whichever activities your students complete, we'd love to see the results, so please share them with @boemuseum **#TheFutureofMoney**

Object in focus: Moneybox

Mathematics curriculum topics: Names of 3D shapes; volume of 3D shapes; compound shapes; nets of 3D shapes

Money boxes represent many people’s first experience of saving money and learning to manage it for themselves. They come in all shapes and sizes and many people chose to collect them. This one is in the shape of a character from a 1980s comic book series, Teenage Mutant Ninja Turtles.

Student activity 1: The shape of money

Task 1

Find an example of a moneybox and describe its shape. For example, the turtle moneybox could be described as having a head represented by a sphere and a body represented by a cuboid.

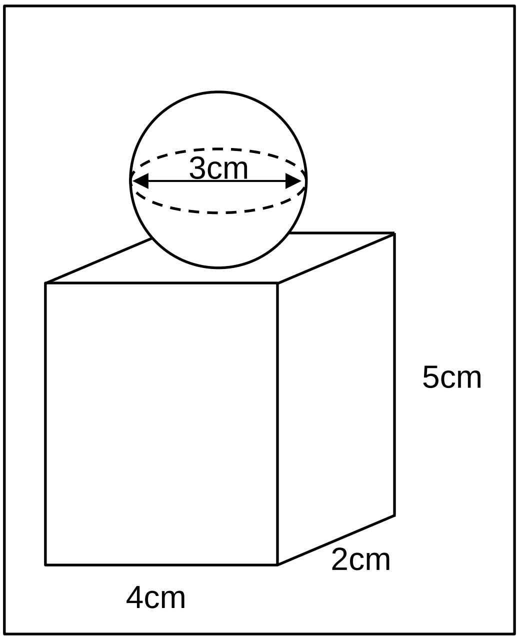
Look at your moneybox and think about its volume. How much space is there to store coins?

Estimate how much money could be stored in your money box. Guess how many of your chosen size of coin could fit inside.

If you have the moneybox and coins, calculate the actual volume.

Example:

If you represent the turtle money box using the shapes described above with the measurements shown in the diagram below you would calculate the volume of the sphere and the volume of the cuboid, and add them together:



Volume of Cuboid

Volume $= l \times w \times h$

$= 4\text{cm} \times 2\text{cm} \times 5\text{cm}$

$= 40\text{cm}^3$

Volume of Sphere

Volume $= \frac{4}{3} \times \pi \times r^3$

$= \frac{4}{3} \times \pi \times 1.5^3$

$= 14.1\text{cm}^3$ (1dp)

Total Volume

Total Volume = Volume of Cuboid + Volume of Sphere

$= 40\text{cm}^3 + 14.1\text{cm}^3$

$= 54.1\text{cm}^3$

Task 2

1. Print one of the net shape templates (cube or triangular prism) below onto thin card.

2. Carefully cut out the coin slot. You can also decorate or colour the faces. *Challenge: can you draw a pattern on each face before you cut out the net so that it will match up with patterns on the other faces once the 3D shape is built?*

3. Carefully cut out the rest of the net, fold along the creases, and use the tabs to stick it together to create a 3D shape money box.

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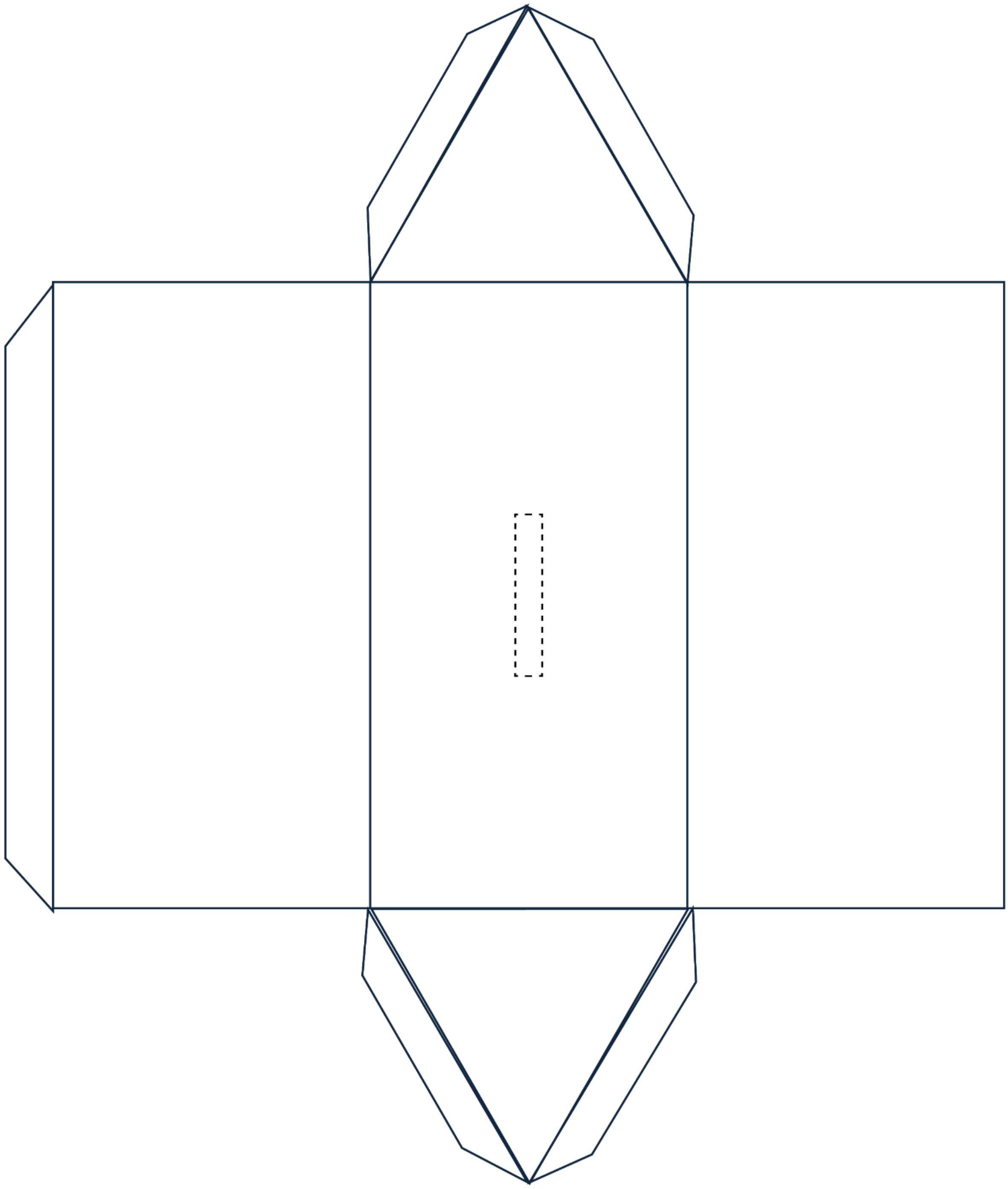

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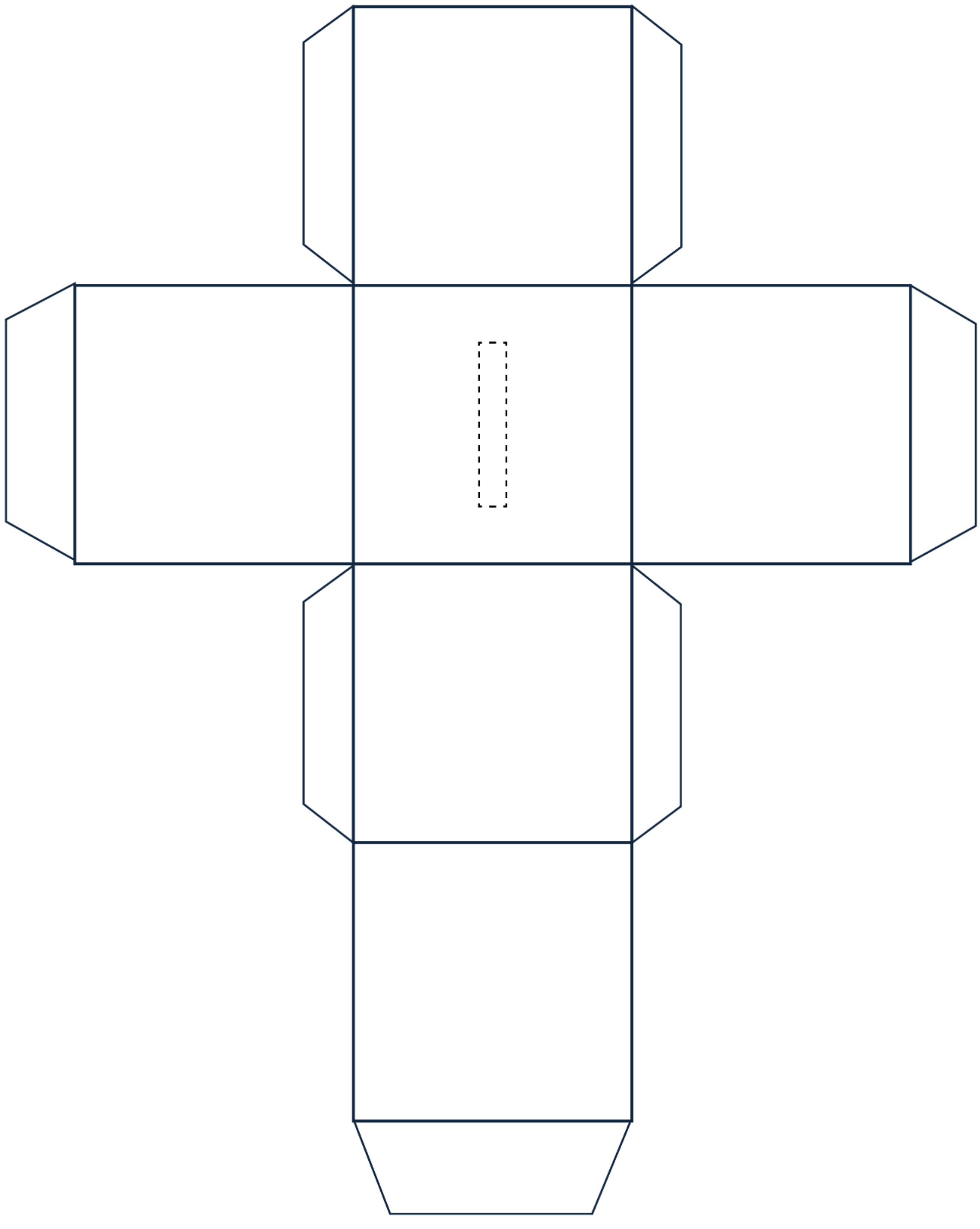
Future of Money



Object in focus: Toy till

Mathematics curriculum topics: Adding; subtracting; multiplying and dividing with decimals

One way that young children learn is by watching adults and copying their behaviour. Toy money and games allows children to experience using money and paying for things as part of their play. This toy till features several different payment methods, including cash and a card reader, helping young children recognise that there are different ways to pay for things.

Student activity 2: Designing an exhibition space

Managing a budget is a key skill for looking after your own money. It is also an important part of many jobs as this activity will demonstrate.

Your task is to design your own exhibition focused on “The Future of Money”. To design your exhibition you will need to work closely to a set budget (determined by your teacher). You need to locate and buy the objects that will feature in your exhibition and also the furniture you will use to display them.

It’s important to consider that not all objects featured in an exhibition have a high monetary value, some may represent a particular point in time or an important event. Equally, you may decide that a high value item, perhaps one that is rare or unusual, might attract lots of visitors. The choice is yours!

Task 1

a) Produce a list of items that will feature in your exhibition. Include prices of individual items (your exhibition items and furniture to display them) and the total cost.

b) Will you charge an entry fee for your exhibition? If so, how much will you charge? How many tickets would you need to sell to recover your costs?

Task 2

a) Choose a space for your exhibition – it might be an area of the school hall or a classroom. Calculate the total area of the space.

b) Calculate the area of your exhibition furniture. Have you left enough space for visitors to move freely around the exhibition?

Object in focus: GoHenry card

Mathematics curriculum topics: Problem solving

Credit: GoHenry

Prepaid debit cards provide a way for children and young people to practise using money in the real world and to develop important skills including budgeting and saving. Schemes are available from a variety of providers with cards often attached to an app featuring tutorials and learning activities.

Student activity 3: Check digit calculation

Every debit and credit card has a unique 16-digit number that identifies the correct account when paying for things.

There are lots of systems in place that are aimed at preventing people from using other people's cards to pay for things *on purpose*, this is called fraud. There are also systems designed to make sure that this doesn't happen by accident. One used by many card providers is called "the Luhn Algorithm". This activity explores how it works:

In a typical credit card number, the first fifteen digits are determined by the bank that issued the card. The final, sixteenth, digit is calculated mathematically from the others.

Here's a randomly generated fifteen-digit number (with a "?" for the unknown sixteenth digit):

2860 4953 7691 357?

To calculate the sixteenth digit, use the following process (writing the card number in a table like this makes it easier - The numbers in the top row show the position of each digit):

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
2	8	6	0	4	9	5	3	7	6	9	1	3	5	7	?

1. Double every number that is in an odd-numbered position:

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
4	8	12	0	8	9	10	3	14	6	18	1	6	5	14	?

2. If any of the numbers now have two digits, add those digits together (e.g., the number in position **3** is 12, so 1 + 2 = 3). This gives us:

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
4	8	3	0	8	9	1	3	5	6	9	1	6	5	5	?

3. Now add all of these numbers together:

   4 + 8 + 3 + 0 + 8 + 9 + 1 + 3 + 5 + 6 + 9 + 1 + 6 + 5 + 5 = 73.

4. The sixteenth digit is whatever we need to add to the sum from step 3 to round it up to the next multiple of 10.

   In this case, 72 + 7 = 80, so the missing digit is 7. This means that the full sixteen-digit card number is:

2860 4953 7691 3577

When a credit or debit card is used to make a payment, a computer uses this algorithm to calculate what the final digit *should* be and then checks that it *is* that number. This is why the final digit is called a “check digit”. If any of the digits in the card number have been mistyped the check digit will register as incorrect, and the user is prompted to re-enter the number.

Task 1

a) Use the algorithm to calculate the check digit for these credit card numbers:

i) `8942 0497 4954 838?`

ii) `6496 7107 6609 726?`

iii) `7058 6743 5065 057?`

b) Which of these credit card numbers are invalid?

Hint: If the check digit is incorrect, the card number is invalid!

i) `2182 0864 7115 3309`

ii) `8166 6722 9321 7606`

iii) `3185 8647 8083 2572`

Student activity 3: Supporting notes for teachers

Task 1

a)

i) 5 ii) 7 iii) 6

b)

i) Valid ii) Invalid iii) Valid

The Luhn Algorithm should work with any credit or debit card number, but please remind students of the importance of not sharing this information.

Object in focus: Polymer banknote shred

Mathematics curriculum topics: Units of measurement; calculating with decimals; standard form

Modern banknotes are made of polymer, a type of plastic. This means that the notes themselves last much longer than paper banknotes, but they do wear out eventually! When they reach the end of their usable life, polymer banknotes can be shredded and recycled into polypropylene pellets that can be used to make a variety of things from plant pots to housing panels.

Student activity 4: Recycled banknotes

A £5 polymer banknote has a mass of about 0.7g. The £5 paper banknotes had a mass of around 0.9g.

Task 1

1. How much heavier would £1,000,000 be in £5 paper banknotes than in £5 polymer banknotes?

2. A plant pot made from recycled £5 polymer banknotes has a mass of 0.4kg. How many £5 polymer banknotes must have been recycled to make this plant pot?

Task 2

In 2022 there were an estimated 399,000,000 £5 polymer notes in circulation.

a) What is the total value of these notes?

b) What is the total mass of these notes?

A water bottle made from recycled polypropylene has a mass of 180g.

c) How many of these water bottles could be made if all the £5 polymer notes in circulation in 2022 were recycled?

Student activity 4: Supporting notes for teachers

Task 1

1. £1,000,000 would require 200,000 £5 notes.

200,000 paper £5 notes would weigh 200,000 × 0.9g = 180,000g = 180kg

200,000 polymer £5 notes would weigh 200,000 × 0.7g = 140,000g = 140kg

So £1m in paper banknotes would be **40kg heavier** than £1m in polymer banknotes.

2. 0.4kg = 400g

400g / 0.7g = 571.428…

572 £5 polymer banknotes would need to be recycled to make the plant pot.

Task 2

a) 399,000,000 × £5 = £1,995,000,000

b) 399,000,000 × 0.7g = 279,300,000g or 279,300kg or 297.3 Tonnes

c) 279,300,000g / 180g = 1,551,666.666…

1,551,666 water bottles could be made.

Extend this:

You can find more details about different banknotes, including their sizes, at: **https://www.bankofengland.co.uk/banknotes/counterfeit-banknotes/how-to-check-your-banknotes**