GEORGIAN

Aberdeen

LEVEL 2

LEARNING RESOURCE

PRODUCED BY

Aberdeen City Council,
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with funding from Historic Environment Scotland.

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PICTURES

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GEORGIAN ABERDEEN

TOWN PLANNING & ARCHITECTURE

Introduction

Through the learning resource *Georgian Aberdeen—town planning & architecture* pupils will be invited to explore the role that Georgian town planning and architectural design played in the development of Aberdeen's city centre.

Who is this resource aimed at?

This learning resource is aimed at primary 5–7 pupils (Level 2).
Group work is aimed at supporting pupils of varied abilities to work through the activities, while some extension topics allow broader learning and working at different levels.

How to use this resource

The learning resource pack is structured into five sections, which we have termed lessons. Each lesson focusses on a specific element relating to Georgian Aberdeen. The pack is structured to allow an overview of the how Georgian society influenced towns and cities, to then looking closer at features of it including architecture and infrastructure.

- LESSON 1 — *Exploring maps*
- LESSON 2 — *Town Planning*
- LESSON 3 — *The Improvement Acts*
- LESSON 4 — *Neo-classical Architecture*
- LESSON 5 — *Union Bridge*

Each lesson builds on learning from the previous, though they can be studied as stand-alone topics if desired.

It should take around half a day to complete each of the five lessons. With extension topic/s each lesson could be expanded into a full day of learning and activities.

The lessons begin with information aimed teachers. This includes some suggested extension topics. The main body of each lesson is aimed at the pupils. While directly addressing the pupils it is intended that they would progress through the lesson as a class, at times breaking into groups or working individually as suggested. ❊

LESSON 1

EXPLORING MAPS

Teacher Section

EXPERIENCES & OUTCOMES

Social studies

I can interpret historical evidence from a range of periods to help to build a picture of Scotland's heritage and my sense of chronology. SOC 2-02a

I can investigate a Scottish historical theme to discover how past events or the actions of individuals or groups have shaped Scottish society. SOC 2-03a

Numeracy and mathematics

I can use my knowledge of the sizes of familiar objects or places to assist me when making an estimate of measure. MNU 2-11a

Having investigated where, why and how scale is used and expressed, I can apply my understanding to interpret simple models, maps and plans. MTH 2-17d

INTRODUCTION TO THE LESSON

This lesson focuses on using historic maps as primary evidence for understanding changes in our community over time. It requires an ability to use online resources and to link historic maps with contemporary mapping and aerial photography. The lesson begins at a very local scale (your school) in the

present day and through each activity takes a step back in time and looks at the broader context.

AIMS OF THE LESSON

- Pupils will develop an understanding of how Aberdeen changed during the Georgian era by learning about the act of planning and through exploring maps and town plans.
- Pupils will understand differences between town plans and maps, their contexts, functions and features.

NOTES ON THE LESSON & MATERIALS REQUIRED

The resources for this lesson are free online resources from the National Library of Scotland (NLS). Links for each map are provided in the lesson content. These resources are not primarily aimed at a younger audience but should be suitable for most level 2 pupils.

An additional NLS resource is included for some activities, which some pupils may find more intuitive to navigate. https://digital.nls.uk/learning/you-are-here/. These NLS pages are aimed at school aged pupils and include additional activities and online quizzes you may wish to use to compliment this lesson.

This lesson is very focussed on the online mapping and subject to the pupils' abilities and interests you may wish to include one or more of the extension topics to vary the activities and take them away from screens.

NOTES ON THE CONTENT OF THE PACKS

The following notes supplement the content in the pupil's pack and offer tips and further information for teachers. They are set out under the headings in the lesson content.

1.1 *Our school over time*—Most of the maps used in this lesson are in imperial measurements. They are expressed as 'X inches to the mile' rather than as ratios. A lexical scale may be easier to visualise than a ratio, but only if you know what an inch and a mile are (which requires a knowledge of English and of imperial measurements). The lesson introduces the idea of lexical scales, fractions and bar or graphic scales but does not expand in these in great detail. Subject to the level the pupils are working at there is scope to explore this in more detail as the pupils work through the lesson. This could include converting between lexical scales, fractions and bar scales. Some of the historic Ordnance Survey maps have all three alongside each other at the bottom of the map. This can help pupils to understand that a map can be drawn at one scale but that the scale can described in different ways.

1.1 *Class discussion at the end of this activity*—Depending on the location of your school the changes may include agricultural/woodland becoming residential areas, rural becoming urban, industry changing and/or moving out of the city centre and changes in transport. You may wish to invite the pupils to work in groups (giving each group specific changes from the combined list the class produced) to discuss what they think has driven change.

1.2 *Comparing multiple maps*—It may help in comparing the historic Ordnance Survey maps to even earlier maps for the pupils to either have two tabs open on their screen, or for the Ordnance Survey side-by-side maps to remain on the class whiteboard while pupils explore the earlier maps on their devices.

1.3 *Class discussion at the end of this activity*—When discussing the changes between 1700s and 1800s invite each group to share with the class a change that they have identified. Thinking back to what they thought had driven change between Victorian times and now invite them to think about what may have driven the changes during the Georgian era.

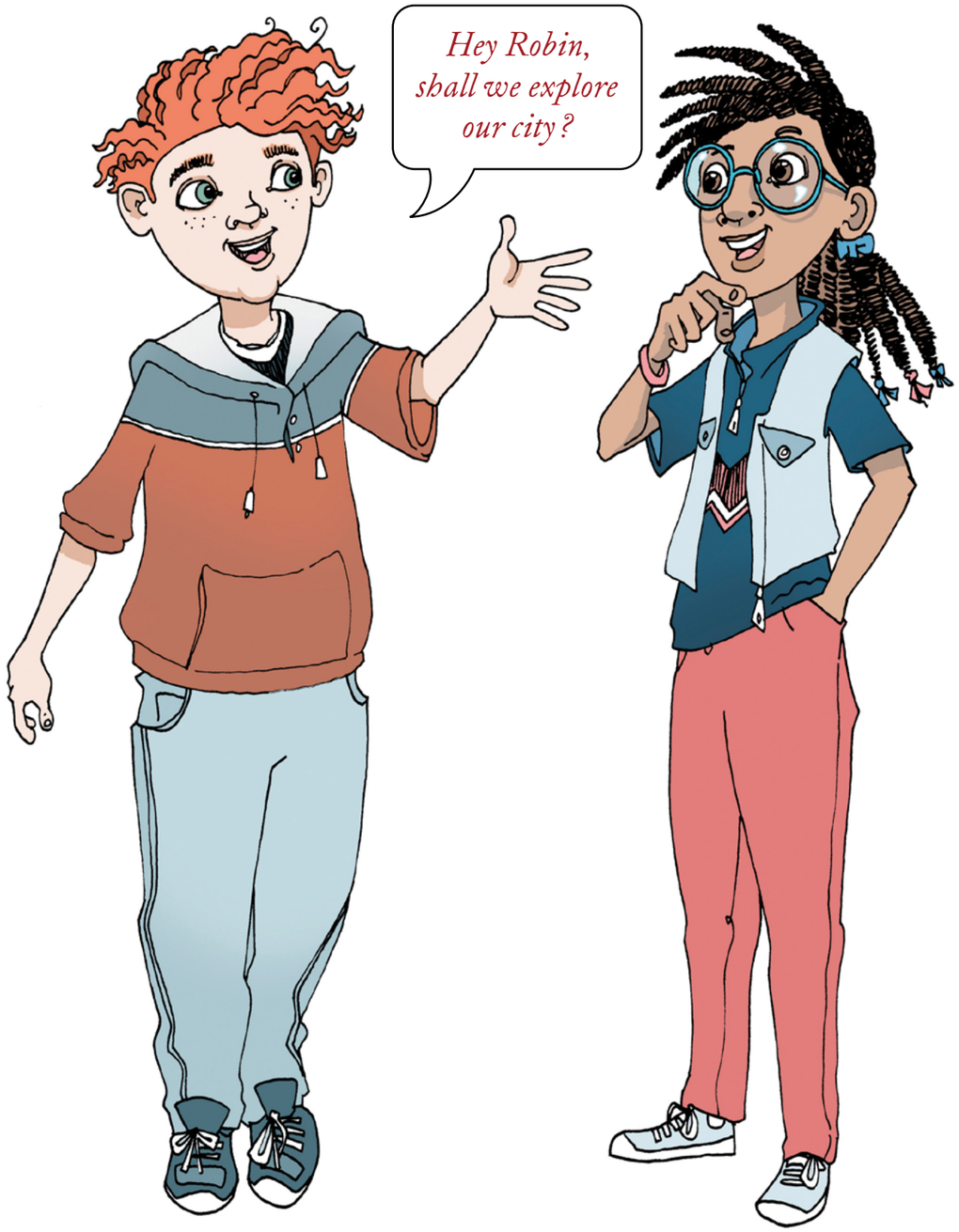
EXTENSION ACTIVITIES & TOPICS

What are maps?—Having introduced what a map is you could invite the pupils to find a book in the school library that includes a map/s. Ask them to identify whether it is a map of a real or imaginary place and to discuss their chosen maps in groups. Perhaps a pupil has a favourite map already? They might like to explain why they like the map. Does it help them to navigate or explore the real world or does it take them into an imaginary world? What are the most popular maps amongst your class?

Scale—Ask the pupils to divide into pairs or small groups. The class will collectively draw a scale plan of their classroom or a part of the wider school environment (e.g. a corner of the playground with play equipment or other features). Maps tend to be smaller scale (e.g. 1:2,500 or 1:50,000) and plans larger scale (e.g. architectural drawings might be 1:100 or 1:20). This exercise is about understanding scales and ratios and applies equally to drawing a plan or a map.

Each group should be tasked with measuring one key element of the chosen space, whether the overall dimensions of the space or the footprint of objects within that space (e.g. desks, rugs, bookcases, swings, sandpit). Each group will convert their measurements into the selected scale and draw it to scale on a piece of paper. 1:100 is the probably easiest scale to worth with, but 1:50 or 1:20 might be more appropriate given the size of the space they are mapping and their experience with ratios. It will depend too on the length of the tape measures you have available. They should then cut out their scaled drawings and place them on the scaled plan (drawn by one of the groups) in the appropriate location. Has everyone drawn to the same scale? If an object doesn't look quite right, ask the pupils to check the measurements and calculations. A simple version of this task is to have some pupils draw the classroom to scale and other pupils to draw their own desks to scale. At the end of the lesson they may wish to illustrate their plan/map is a similar fashion to the 1661 map.

1.4 Having gone back to a highly illustrated map from the 1600s, ask the pupils to *produce a map of their school and immediate area* (somewhere they are familiar with) in the style of the 1600s map. What illustrations would they include, to convey a clear sense of the place to someone using the map? What buildings of features would they single out for inclusion in the key? ❊



Alex *Robin*

LESSON 1

EXPLORING MAPS

Pupil Section

1.1 *What are maps?*

Maps show scaled down versions of places, both real and imagined. Fiction books will sometimes have maps of imaginary places in them. The author JRR Tolkien included maps in some of his most famous books, including *The Hobbit* and *The Lord of the Rings*. Maps can also show a combination of real and imagined places, such as the development plans that Councils produce. These plans show the vision for the future of real place. Not all the proposed changes may happen.

Scale

The scale of a map is the ratio between the distance on the map and the distance on the ground. Maps are drawn at different scales as maps have different purposes. Some maps show large areas and have less detail (e.g. a world map that shows every country). Some are drawn with a lot of detail but cover less area (e.g. a map you might take of a walk in the hills, that shows walking tracks, burns and field boundaries).

On a map that is drawn at a scale of 1:100, 1 unit on the map represents 100 units on the ground. On our modern, metric maps this means that 1cm on the map represents 100cm on the ground. At a scale of 1:100,000, 1cm in the map represents 100,000cm on the ground.

As 100,000cm is equal to 1km then on a 1:100,000 map every 1cm represents 1km on the ground.

In this example, the scale 1:100,000 is expressed as a fraction.

1.2 *Our community over time*—1800s–today

In this lesson we will focus on resources available on the National Library for Scotland website, which provides digital access to historic and modern maps. The old Ordnance Survey (OS) maps used pre-metric measurements of inches and miles. They used words to describe their scale rather than fractions. The most detailed old OS maps were drawn at a scale of '25 inches to the mile'. This was commonly referred to as a '25 inch map', with every 25 inches on the map representing 1 mile on the ground. On the OS maps drawn at the scale '6 inches to the mile', one mile on the ground was fitted into just 6 inches on the map, meaning less detail could be included than on the 25 inch scale maps.

Perhaps you find it easier to visualise a scale that is described in words rather than a fraction? Most maps also have a bar or graphic scale on them. Does this help you to visualise the scale of the map? As we look at various maps try to find how they have described the map's scale: verbally, fraction or bar scale. Do any maps use more than one?

For the map work you could work in pairs or small groups.

Begin by going to https://maps.nls.uk/ then select the 'side by side viewer' option. On the left side select the 'OS Six Inch 1840s–1880s County Layers' map. This map is from the late 1800s. If your school is near the city centre then on the left side you could select 'OS 1:500/1:528 Towns 1840s–1890s'. This map is from the same period but is at a different scale and has a lot more detail.

On the right side of the screen there is a selection of maps and aerial photographs from the present day. The options of 'OSMaps API' and 'Bing Satellite' contain the best information for this activity.

Locate your school on the modern-day map or satellite image. Does your school appear on the historic map? Is your home on the old map? Do you recognise your neighbourhood on the old map?

Compare the area around your school and where you live.

- ✶ What is the same and what has changed between the two maps?
- ✶ What are the biggest changes you can find?

In your pairs or groups make some notes about the changes you have identified. If there are any symbols, building types or descriptions you do not recognise you could research these. The map symbols have changed over time but the following link provides a good key to the Ordnance Survey map symbols. https://maps.nls.uk/view/128076891

Share your findings with the class to create a list of all the changes the class has identified.

Top Tip—If you are struggling to understand the side-by-side maps then an alternative page for comparing historic and modern mapping is https://digital.nls.uk/learning/you-are-here/. You will need to pan up the map to locate Aberdeen. This is an easy tool to use but the side-by-side viewer has more detailed historic maps which you may find helpful. If you are working in small groups, some pupils may wish to use this second link and compare their findings with the rest of the group.

Having identified the similarities and differences in your area on the historic and modern maps, discuss as a class why you think there have been these changes over time. What do you think has driven the change?

1.3 *Union Street over time*—1700s–1800s

As a class, use the side-by-side viewer on a whiteboard to explore changes over the same time in and around Union Street. The very detailed historic map ('OS 1:500/1:528 Towns 1840s–1890s') is best for this activity.

Are the changes around Union Street similar or different to those your identified around your school? Has there been more or less change around Union Street? Can your class identify any buildings or structures that you either recognise on the old map or that you have never heard of and are no longer there?

The old maps we have explored so far only go as far back as

Victorian times, from the 1860s to the 1890s. Let's see what changes can you identify on even earlier maps.

The following link is for the 'Plan of the City of Aberdeen with all the enclosures surrounding the town from a survey taken 1789'. The map maker was Alexander Milne. https://maps.nls.uk/view/74400007

There have been some big changes in Aberdeen since Alexander Milne made his map in 1789. Take time in your groups to locate some features that appear on all the maps. This will help you to identify similarities and changes over time.

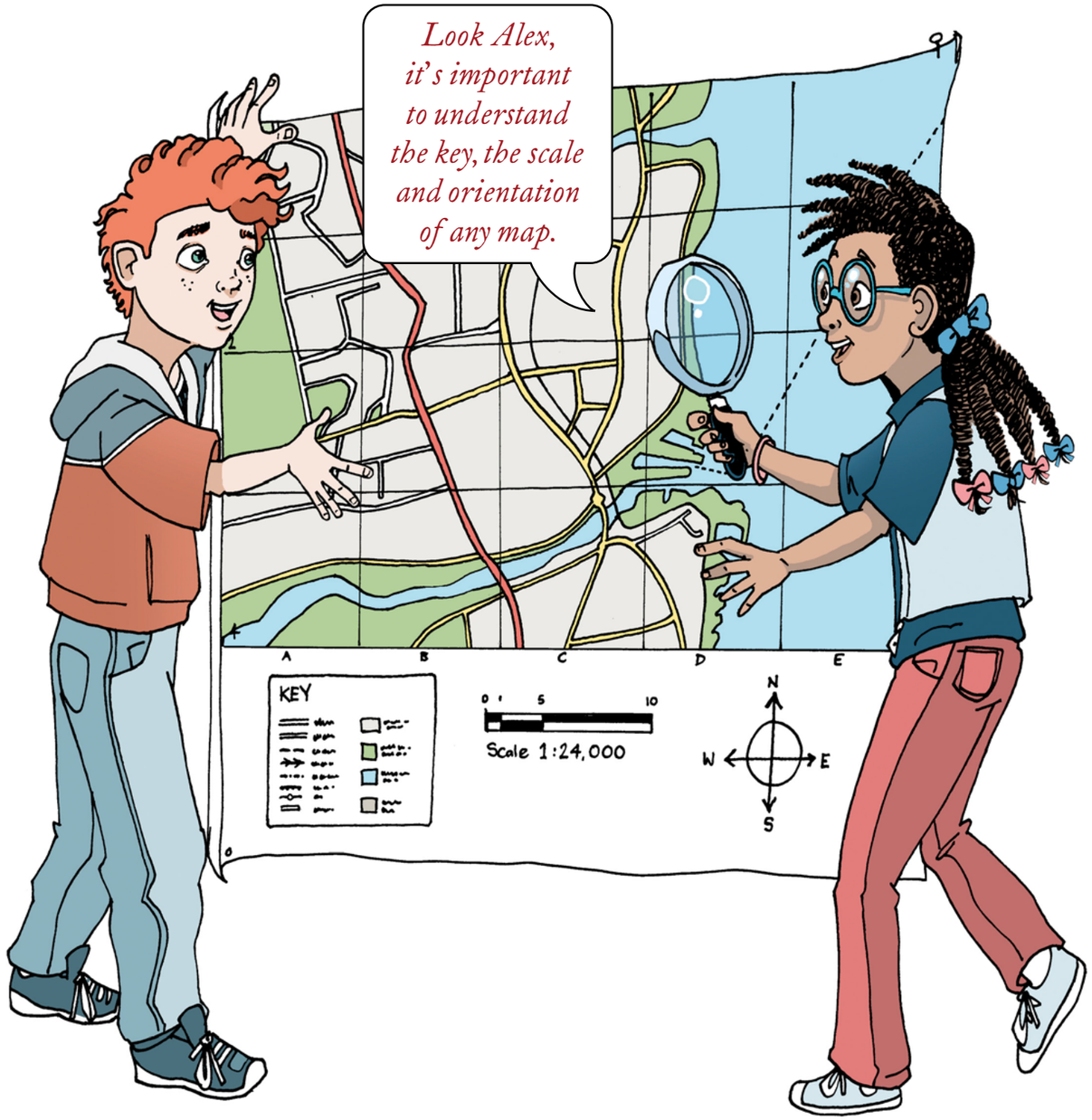
Top Tip—You might identify these features from the names of streets or important buildings. Or you might see patterns on the maps that the streets or natural features (such as burns or hills) create. The north arrow is also an important tool when comparing maps.

Can your group identify any natural features that were there in 1789 but which are no longer evident? What has replaced any features or streets that have been lost? What are the biggest changes in the city between 1789 and the late 1800s?

1.4 *Aberdeen*—1600s

Having identified some major changes between the 1700s and the 1800s we will now look at one final historic map.

James Gordon's map of 1661 (https://maps.nls.uk/view/74400885)



provides an even earlier reference for comparison. The illustrations may help you in thinking about how and why Aberdeen developed in the way it did. The text also provides a lot of clues, though the old spelling and use of Latin language can be a challenge.

In your groups select one of the following questions to explore:

- What do the illustrations in the 1661 map tell us about how people lived and travelled in the 1600s?
- What public or civic buildings can you find on the map? What function do they serve (e.g. education, health, religion) and what do they tell us about life in Aberdeen at the time ?
- What natural features does the map show which tells us something about why Aberdeen developed in the location it did? What do people need to survive? What were the threats in the past ?

Share your findings as a class. Remember to present your evidence from the map.

Do you have a favourite map from those you have used in this activity? Can you imagine life in Aberdeen in the 1600s, the 1700s and the 1800s? ❊

LESSON 2

TOWN PLANNING

Teacher Section

EXPERIENCES & OUTCOMES

Mathematics

I can illustrate the lines of symmetry for a range of 2D shapes and apply my understanding to create and complete symmetrical pictures and patterns. MTH 2-19a

I can draw 2D shapes and make representations of 3D objects using an appropriate range of methods and efficient use of resources. MTH 2-16c

Social Studies

I can compare and contrast a society in the past with my own and contribute to a discussion of the similarities and differences. SOC 2-04a

INTRODUCTION TO THE LESSON

This lesson considers the key principles in Georgian town planning, how these were applied in Aberdeen and what the legacy of planning in the Georgian era is on the city today.

The pupils will begin by developing individual models or plans at a very local level and combining these to create a town plan. As they are introduced to key principles in Georgian town planning they will review their town plan, applying what they have learnt to the plan.

AIMS OF THE LESSON

- Pupils will gain an understanding of the Georgian era and how society, economics, culture and interests shaped the architecture and layout of the city of Aberdeen.
- Pupils will be able to annotate and utilise a key to depict features in a Georgian town plan and critically consider the experience of people living in Aberdeen during that period.

NOTES ON THE LESSON & MATERIALS REQUIRED

This lesson does not require any specialist materials. Alongside some online resources (National Library for Scotland mapping) it requires the following materials:

- A4 paper
- Pens/pencils/markers
- Glue, tape & scissors
- Card, coloured paper, general crafting materials or off-cuts and/or found objects from nature.

NOTES ON THE CONTENT OF THE PACKS

The following notes supplement to the content in the pupil's pack and offer tips and further information for teachers. They are set out under the headings in the lesson content.

2.1 *The collective map* that the pupils create in this first activity will be revisited and reworked through successive activities in this lesson. It would equally suit working in an outdoor learning environment as an indoor one. Using resources such as a sandpit to create natural features (hills, rivers) as a base for the planning activities would add to the lesson, as the pupils might then opt to remove these features from their city as they move from their more organic plan (at the start) to a more controlled grid pattern (at the end of the lesson). Equally

the base for their plans might be the classroom floor, with furniture and rugs to navigate around and over.

EXTENSION TOPICS

Transatlantic slave trade—One factor that contributed towards Aberdeen's growth of trade in the 1700s and 1800s was its involvement in the trade of enslaved African people. Slave ships did not sail from Aberdeen but goods produced by enslaved people (such as sugar and rum) or used in the slave trade (such as linen for clothing worn by enslaved people) passed through the port. Aberdonian and north-east merchants were also responsible for enslaving African people, as traders and owners, often making vast wealth which was invested at home in Scotland. The University of Aberdeen has online learning resources which, though aimed at secondary aged pupils, can be adapted for level 2. https://exhibitions.abdn.ac.uk/university-collections/exhibits/show/a-north-east-story/introduction

A shorter NE learning resource, aimed at (and developed by) primary pupils is the graphic novel *Aye, it wis aabody*, which explores the links between Finzean Primary School and the transatlantic slave trade. https://issuu.com/magictorchcomics/docs/aye_it_was_aabody__issuu_ ❊

LESSON 2

TOWN PLANNING

Pupil Section

Having explored the development of Aberdeen over the centuries we have seen that the city has developed and grown in different ways. Sometimes the development has been gradual and followed the natural features of the landscape. At other times the development has been more planned. The development of Union Street from the 1790s resulted in the loss of some of the natural features that had once dominated Aberdeen. It was a very ambitious plan. We can still see some of the evidence of the scale of the undertaking today, in the arches and bridges of Union Street. The city continues to grow and to change. In the 1700s and 1800s it was architects and engineers who designed our cities. Today it is professional town planners who ensure that our towns and cities meet the needs of the people who live and work in them.

2.1 *Planning a town*

What do you most like doing in the city centre? This could be visiting a

museum or gallery, playing in a park, shopping or going to the cinema. It might be being at school or at home. Take ten minuntes to find no more than six objects in your classroom or playground that you can use to build a model or plan that represents you favourite city centre activity. Use an A4 piece of paper, your found objects and other paper, cardboard, glue/tape and pens/pencils create your model or plan.

In groups, or as a class, describe the model/plan you have made and how you feel about that place or activity. Write a description of the activity or place on the plan/model you have created, as it is important as we work through this lesson that everyone knows what each A4 plan or model represents.

As a class arrange the individual plans/models into a town or city. Think about the types of places that you and your classmates have identified. Are there similar types of buildings, places or activities? Is there anything missing from your city? If your city doesn't have any parks, houses, public buildings or shops then create some more A4 plans and incorporate them into your city plan.

How could these be arranged to meet the needs of the citizens of the city? How will people get around your city?

In arranging your town/city, do you each do your own thing or did you co-ordinate and plan together?

2.2 *Georgian Aberdeen*

What was the Georgian era?

The Georgian era refers to the period of British history that corresponds to the reigns of the first four Hanoverian kings of Great Britain—George I, George II, George III, and George IV—spanning from 1714 to 1830. Just before this Scotland and England united forming Great Britain in 1707.

Through this period there were many changes and developments in areas of technology, science, education, social and class structure, and trade. It was an era that brought with it the belief that science and logic gave people more knowledge and understanding than tradition and religion. The name given to this period of discovery and learning is the Enlightenment.

Development in technology from the 1760s resulted in a period of change that came to be known as the Industrial Revolution. Industry moved from largely agricultural (farming) to mechanised manufacturing (factories). There was increased use in water and steam power, to power the new industries. The population grew rapidly and many people moved from the countryside into the towns and cities, following the new jobs in factories and industry. Georgian Scotland also grew wealthy on the profits of empire and the trade of enslaved people from Africa.

Up until this time most people in cities lived cheek by jowl in the same sort of buildings. Cities were often crowded and dirty. The wealth created during the Georgian era saw new types of dwellings designed. Wealthy people built refined and elegant town houses, away from the

tenement houses and other building such as shops or workshops. The Georgians designed their cities around the Enlightenment ideals of order, beauty and progress.

Geometry & Symmetry

In designing Georgian cities, the architects and engineers of the time used grids to layout their plans. They sought to impose order in their cities through the use of grids where the streets all intersect at right angles. In Edinburgh a 'New Town' was designed in the 1760s on a grid layout. It was separate from the crowded and unsanitary old town, divided by the very polluted Nor Loch which was drained to create the Princes Street Gardens.

In Aberdeen the late 1700s brought a number of developments, which were the start of a new era of modern planned growth in the city. Marischal Street was built in 1760, linking the town centre with the quayside. By bridging over Virginia Street, Marischal Street was able to link the quayside with the higher ground of Castle Street without being steep or winding.

When the town council decided in the late 1700s to improve the southern approach to the city (to allow it to expand westwards) they settled on a grand, straight street to replace the hilly, winding, streets of the medieval plan.

We saw in the first lesson how the creation of Union Street, with smaller streets running off it, imposed a new symmetry on the city.

We can see this very clearly in the 1810 plan of the city drawn by John Smith. *View map:* Smith, John, Plan of the city of Aberdeen and its improvements, with the wet and dry docks and other works connec... - Town Plans / Views, 1580-1919—https://maps.nls.uk/view/216390219

This plan is a vision for the city. It shows both what was there (what existed in 1810) and what was proposed to be built. One of the notes in the 'References' tells us quite clearly that not everything shown on the plan had been built by the time the plan was drawn. Can you find the reference and then link it back to what has been drawn on the plan? What do you notice about the shape and scale of the streets and blocks planned but not yet built? How do they compare with the historic streets?

We know from records and drawings that some of the proposed streets and buildings shown on the 1810 plan were built, but some were not built at all, such as the 'proposed new street' from the harbour to Union Street. A new street was laid out linking the harbour and Union Street, but this wasn't until 1840 and the new street (Market Street) was further to the east than the proposed new street in the 1810 plan.

The laying out of Union Street was a huge undertaking. Development was slow and very expensive.

Activity—work together as a class to redesign your city around the Georgian planning convention of using a grid plan and symmetry.

Will you remove any 'natural' features to make a grid plan? Will

all of the old plan be changed, or are there buildings, parks, streets or natural features that you have to (or want to) keep? You may wish to photograph your first plan so you can compare it with your new grid plan city. Perhaps your original plan was already based on a grid plan? If so, why did you design it around a grid initially?

Hierarchy

Georgian grid plans were often made up of streets of subtly different scales. There was a hierarchy to the streets that reflected the ordering and governing of Georgian society. The different sizes of the streets and building plots could accommodate people of differing social status and wealth. This hierarchy is also reflected in the naming of the streets. Square or Circus were names given to some of the grander streets, of higher social importance. Lanes or mews were smaller or humbler.

Georgians often placed importance on certain streets within towns and cities, as a focal points for citizens to gather or as places to buy and sell goods.

Union Street was laid out to link several turnpike (or toll) roads, allowing expansion of the city to the west of the Denburn Valley and providing better transport routes for goods into the city from the south. The turnpike roads were toll roads that people had to pay a toll to use. They were constructed from the late 1700s and linked key towns within Aberdeenshire and the city. Many of the main roads in Aberdeen today follow the route of the old toll roads.

The width of Union Street permitted development of the buildings on each side of a scale and quality, that firmly established the street as the City's principal Street, even to this day, whilst the medieval street pattern around the Green and the St Nicholas Church remained largely intact.

Off Union Street is Golden Square, which was laid out in 1810 as a grand residential square with a formal garden at its centre. Off the Square are streets, and off the street are lanes. Such lanes provided service entrances for the grand houses, places to stable horses and house domestic staff.

Activity—Take a closer look at the 1810 plan of Aberdeen. Remember this map shows both some of the reality of Aberdeen in 1810 as well as some proposed changes.

Break into 4 groups.

In your groups, on the 1810 map identify the location of the buildings that match the headings below. The 'references' key will be critical to doing this. What do you notice about where the different activities are located? Are they clustered together or spread around the city?

Top Tip—you might wish to take a screenshot of the map and then make notes or circle any clusters of similar buildings on the saved screenshot.

✶ *Green space and health*

The Georgians valued green spaces, parks and gardens within their

cities. They believed in the importance of nature, recreational areas and a clean environment as vital for the well-being and health of residents. There was also an important social dimension to these spaces, where people could parade and display their social etiquette.

✶ *Residential*

The Georgians planned their towns and cities around the function of buildings and public spaces. They often separated people's homes (residences) from business and trade. The grander houses were often situated in prime locations, on main streets and residential squares, shops and less grand houses on smaller or side streets and the poorest dwellings on streets off those. Union Street was originally laid out as a residential street, with buildings stipulated as being 3 storeys plus attic made of dressed granite (granite shaped into regular blocks by stonemasons, rather than the irregular rubble of many older buildings).

✶ *Public Buildings*

The Georgians valued the need for public buildings and spaces where they could meet similar people and learn, socialise and enjoy art and entertainment. They believed that this would allow people to develop their own views, opinions and interests about the world. This was a key element in the Enlightenment movement.

✶ *Trade, Docks & Ports*

The Georgians understood the importance of being able to transport

goods and services around freely. To do this they developed more specific and clear routes to the docks and the roads to the west and south. Marischal Street was created in 1760 and was one of the earliest planned streets of the Georgian era, linking the Castle Street with the quayside. With the growth of trade came services such as banking and insurance, which led to the houses of rich merchants being built on Castle Street and Castle Hill.

When all the groups have completed the first exercise you will apply what you have learnt about Georgian grid plans, street hierarchy and the grouping of different activities to redesign your city once more. At the beginning of this exercise, each group should focus on one of the headings above and use the A4 maps/models that match their assigned heading. E.g. if your group has been assigned 'Green Space and Health' as a heading then take all the A4 maps/models that relate to green spaces and health and decide where and how they will be positioned in your class's city plan.

Are there any new buildings, spaces or services that you need to create to complete the town plan?

Thinking back to your first town plan, how has it changed? Which plan do you prefer and why?

2.3 *Wish You Were Here?*

Using what you have explored about the design, layout and features

An Aberdonian hotel owner greeting his guests

of cities and towns in the Georgian era your challenge is to create a postcard from that time by making its front image and giving a brief description of what it is like in Aberdeen on the reverse. It should be written by someone in Aberdeen promoting the city as a good place to visit or to do business in.

You might wish to take on the role of one of the following people:

- Architect.
- Stonemason.
- Scholar (a student, at school or university).
- Wealthy merchant or family.
- Market stall holder.
- Visitor.
- Resident.

Think about their feelings about the city and how it shapes their everyday life. Who are they promoting the city to? Is it a friend or a business acquaintance?

In illustrating the front of your postcard draw on your learning from the *Exploring Maps* lesson and from any sketches you can find from your own research. You could draw a map of the city, a view showing the skyline or a specific building, feature or person. Or you may wish to draw a combination of these. ❊

LESSON 3

IMPROVEMENT ACTS

Teacher Section

EXPERIENCES & OUTCOMES

Literacy

To show my understanding across different areas of learning, I can identify and consider the purpose and main ideas of a text and use supporting detail. LIT 2-16A

I can select ideas and relevant information, organise these in an appropriate way for my purpose and use suitable vocabulary for my audience. LIT 2-06A

I can persuade, argue, explore issues or express an opinion using relevant supporting detail and/or evidence. LIT 2-29A

Social Studies

I can consider the advantages and disadvantages of a proposed land use development and discuss the impact this may have on the community. SOC 2-08B

INTRODUCTION TO THE LESSON

This lesson looks at how legislation helped to shape Georgian Aberdeen. Pupils are invited to understand the impacts of the Improvement Acts through the lives of people who lived in the city. Following the Model UN debates the pupils will be invited role-play in a debate on the motion about the Improvement Act of 1818.

AIMS OF THE LESSON

- Pupils will consider ideas of 'improvement' and its foundation within cities and within their schools
- Pupils will analyse historic text and work with the linguistic qualities to build their own Acts
- Pupils will consider and question the advantages and disadvantages of Improvement Acts in Georgian society
- Pupils will learn to present an argument in a debate and be invited to consider differing views.

NOTES ON THE LESSON & MATERIALS REQUIRED

This lesson requires no materials beyond access to the online resources and general classroom resources such as pens and paper.

NOTES ON THE CONTENT OF THE PACKS

The following notes supplement to the content in the pupil's pack and offer tips and further information for teachers. They are set out under the headings in the lesson content.

3.2—*Improvement Act 1818*

The Act gives an insight into life in Georgian Aberdeen. The full text of the Act is lengthy and complex but subject to your class' abilities you may wish to ask the pupils to work in pairs to transcribe (in general terms, not word for word) a small part of the Act. Where there are terms they don't understand (e.g. sedan chair) ask them to research their meaning. Invite them to share with the class what they have learnt about life in Georgian Aberdeen from their section of the Act.

EXTENSION TOPICS

Rights Respecting Schools—if your school is a Rights Respecting School how might the pupils learning from this lesson feed into the RRSA programme? How can they support positive changes in their own school environment? How can you build on their understanding of local, regional and national politics today to help them develop into responsible, global citizens?

Model UN—taking an issue that is current and of interest or of concern to the children, debate it as a class using either the Model UN debate or a more traditional two teams debating model. This might be something that is happening in Aberdeen or it could be a global issue. Challenge them to reach consensus on the issue, without taking a for/against vote. ❊

LESSON 3

IMPROVEMENT ACTS

Pupil Section

3.1 *Improvement Patrol*

Take a walk around the school in groups or pairs, taking a tablet or clipboard and pen with you. Write down five things that you believe could be 'improved' within the school. You may wish to consider:

- The buildings or playground.
- The natural environment.
- How it feels to be in the school.
- Things relating to health.
- Your ability to focus and learn.
- School rules.

Once you have completed your inspection share your findings with the rest of the class. Are there any areas for improvement that a lot of pupils agree on?

As a class, alongside the list of improvements identify what might

be done to improves the things identified. E.g. if the playground has no grass you could remove some tarmac and plant grass, or you could grow grasses and other plants in raised planters.

Who do you think is responsible for making these improvements and why?

3.2 *Improvement Acts*

An 'Act' is a law that has been agreed by a governing body, such as parliament. During the Georgian era, and after the Union was formed between Scotland and England, a series of Acts were created which allowed the government to take control of town and cities and change things they believed would make people's lives better. These Acts were called the 'Improvement Acts'.

Opposite is the first page of the Aberdeen Improvement Act, 1818.

The full Act is thirty-eight pages long and can still be viewed on the government website: https://www.legislation.gov.uk/ukla/Geo3/58/59/contents/enacted. It is written in English, although the spelling is very different from today's spelling, and it includes phrases in Latin which was common on legal documents until very recently.

The Act sets out the improvements that are to be made, who was responsible for the improvements and how the property owners and occupiers were going to be taxed to pay for the improvements.

Are you able to identify what the main improvements are from the summary opposite?

ANNO QUINQUAGESIMO OCTAVO

GEORGII III. REGIS.

****

Cap. lix.

An Act for better paving, cleanſing, lighting, watching, and improving the Streets, Lanes, and other Public Places and Paſſages of the City of *Aberdeen*, and the Roads and Avenues within the Freedom and Royalty thereof; and for ſupplying the Inhabitants of the ſaid City with Water.

[23d *May* 1818.]

WHEREAS an Act was paſſed in the Thirty-fifth Year of the Reign of His preſent Majeſty, intituled *An Act for the better paving, lighting, cleanſing, and otherwiſe improving the Streets, Lanes, and other Public Paſſages of the City of* Aberdeen, *and the Roads and Avenues within the Royalty thereof; for the better ſupplying the Inhabitants with freſh Water; and for removing and preventing all Obſtructions and Annoyances within the ſaid City and Royalty:* And whereas by the due and faithful Execution of the ſaid Act, and the juſt and regular Application of the Aſſeſſments thereby impoſed and levied, great Benefits have been derived to the ſaid City and Inhabitants thereof: And whereas the ſaid Act has expired, and it would be of eſſential Importance, and tend to promote the Security, Comfort, and Convenience of the ſaid Inhabitants and the Public, if further Proviſion were made for the ſeveral Purpoſes mentioned in the ſaid Act, and Power given for eſtabliſhing a more enlarged Syſtem of Police, and maintaining a regular Patrol or Nightly Watch for the Protection and Security of the ſaid City and In-

[*Local.*] 15 *E* habitants

Streets and pavements were to be paved. This meant granite (sometimes wood) cassies or setts for the streets and stone slabs for pavements. They were to be kept clean, lit (with gas lamps) and kept safe through employing watchmen (to police the streets before the police force was established). And there was to be a public water supply into houses.

The full Act contains a lot of detailed information. This includes things such as:

- Streets were to be widened and new streets were to be built.
- The fine for hanging carpets out (to shake dust and dirt from them) over the public street was five shillings.
- Signs that hung out from buildings, overhanging the public street, were not permitted.
- Market stalls and barrows were not permitted except on market days, and then only on King Street and Castle Street.
- Buildings facing onto public streets had to have rhones (gutters) and downpipes to collect and take away the rainwater.
- The names of the streets were to be put on the buildings, along with house numbers. Removing or damaging a street name or house number could result in a fine of up to twenty shillings.
- Sedan chairs, barrels and wheelbarrows were prohibited from using the foot pavements, unless for crossing the pavement to get directly from a public road to a building.
- Timber, logs of wood and bars of iron were to be transported on

long carts or carriages and the goods were not allowed to hang over the carriage.

- All soil, dirt, ashes and filth, as well as dung from horse and cattle was to be removed from the public streets and disposed of properly.
- Gunpowder was to be stored away from other goods and there was a tax on all gunpowder brought into the city.
- The Act even set out fines for damage to the newly paved streets and compensation if a night watchman was injured as a result of his job.

3.3 *Debating the Improvement Acts*

Sometimes improvement meant that there was a need to clear existing buildings and streets, to make way for new streets. Through the construction of Union Street one area of 'slum tenements' called Putachieside was demolished. This area was known to be cramped, narrow and dirty.

It was to the west of St Katherine's Hill and was lost under Union Street and then also Market Street when it was constructed. It is labelled 'Putachy Side' on the 1820 plan. The following illustration shows Putachieside just before Market Street was laid out: https://emuseum.aberdeencity.gov.uk/objects/110583#

It would have been home to many families and businesses. Where do you think these people would have gone? What impact did 'improvements' such as this have on their lives?

In small groups, or at your tables, discuss what you think were the

advantages and disadvantages of the Aberdeen Improvement Act,1818.

Prepare some notes, or a list, setting out the advantages and disadvantages. Give some thought to why you believe something to be positive or negative.

Were there any 'improvements' that were of benefit to some people, but disadvantaged other people? If so, are you able to imagine how the advantaged and disadvantaged people felt? What were the long-term benefits and did these outweigh any short-term issues?

3.4 *The Great Debate*

Debating is an organised discussion where different people put forward their views on a topic. It can be competitive, with two teams, each taking an opposite view on an issue. It can also be a discussion amongst many people, with lots of different views.

The United Nations (UN) debates issues (which they call 'resolutions') with each member country representing their views. After the resolution has been debated the member states reach a consensus on the resolution (they agree without voting) or they take a vote, with each country having one vote.

Our debate will follow the UN model, but instead of representing the views of a country your groups will represent the views of real and fictional characters from Georgian Aberdeen. Each group will nominate a speaker to take on the role of their character in the debate and put forward their views on the motion. At the end of the debate the

Various roles from 1818 for your debate, including from top left:
a wealthy man and woman, a young boy,
a servant woman, a merchant, a poor mother,
a fisherman and a nightwatchman

audience will be asked to decide the outcome of the debate, by either voting 'for' or 'against' the statement, taking into consideration the views and arguments put forward by the speakers.

The characters are:

- Archibald Simpson (architect, born 1790—died 1847).
- A pupil of the Grammar School.
- Hope Innes (born 1778—died 1857), wife of Gavin Hadden who was merchant and Lord Provost of Aberdeen.
- A cook, working for a wealthy household on the Golden Square.
- A dock worker, loading and unloading goods from sailing ships.
- A young female mill worker at Hadden & Sons stocking factory in The Green.
- A market stall holder, selling their goods from a barrow or basket on the street.

Divide into four to six teams. Each team will be assigned a character by the teacher. The debate will also need a Chair, who will ensure that everyone is respectful, stays on topic and doesn't speak for too long. The Chair will also call the vote at the end.

The groups will debate the statement: *The Improvement Act of 1818 is good for Aberdeen.*

Take some time as a group to consider how your character might have felt about the Improvement Act. Develop your character based on what you have learnt about Georgian Aberdeen. Where did they live and work? How did they get around the city? Did they have any

leisure time? You might wish to do some additional research to develop your character.

What impact did the Act have on their life? Remember, they can't have known what the long-term impact would be on the city. They were living with the reality of the Act being implemented. Think about what some of the other speakers might be saying and be prepared to present your character's experience or view to counter or compliment their arguments.

Prepare some clear and well organised notes for your group's speaker to use during the debate. You might use bullet points or a spider diagram. Remember, you want your character to convince the audience that their view (either for or against the statement) is the correct one.

The Chair will invite each character to speak for a given time. Three to four minutes is quite a long time to speak for, so don't feel you need to prepare pages of notes. A brief and well-formed argument will be easier for the audience to follow.

If you are in the audience then you may wish to take some notes to help you remember what has been said and which arguments you think are the strongest.

After every character has spoken the Chair will invite the audience to vote either 'for' or 'against' the motion.

Did your class agree or disagree with the statement? Did you have an opinion on the statement before the debate? Did the teams debating the statement convince you to change your mind? ❊

LESSON 4

NEOCLASSICAL ARCHITECTURE

Teacher Section

EXPERIENCES & OUTCOMES

Expressive Arts

I can create and present work that shows developing skill in using the visual elements and concepts. EXA 2-03A

Through observing and recording from my experiences across the curriculum, I can create images and objects which show my awareness and recognition of detail. EXA 2-04A

Mathematics

Through practical activities, I can show my understanding of the relationship between 3D objects and their nets. MTH 2-16B

INTRODUCTION TO THE LESSON

In this lesson the pupils will explore the conventions of Neoclassical architecture and apply them to a building of their own design. The lesson includes a lot of hands-on creative activities focussed on drawing, designing and building. To support them in this there is a step-by-step activity on sketching buildings, to develop their confidence and build skills.

AIMS OF THE LESSON

- Pupils will explore the genesis of neo-classical architecture, its cultural and stylistic features, and consider its features and ideas of symmetry and aesthetic qualities.
- Pupils will be invited to create designs for their own neo-classical building using 3D nets, floor plans and knowledge acquired throughout the learning pack.

NOTES ON THE LESSON & MATERIALS REQUIRED

Much of the lesson is working individually, albeit in creative activities that are likely to see the pupils sharing ideas, materials and advice. In the final activity they are invited to collectively create a town or city with their individual models. The ability to draw and built to an exact scale is not necessary, though some pupils may need additional help or guidance with proportions even when building to an approximate scale (their model should have a footprint not larger than A4).

The lesson does not require any specialist materials. The following materials are required:

- Drawing paper.
- Pens/pencils.
- Cardboard (boxes from recycling would be ideal).
- Glue or tape.

NOTES ON THE CONTENT OF THE PACKS

The following notes supplement to the content in the pupil's pack and offer tips and further information for teachers. They are set out under the headings in the lesson content.

4.2—*Like any skill, sketching requires practice*.

Having learnt how to sketch a building from the tutorial you might wish to take the children outside, to sketch their school or buildings in the neighbourhood.

4.6—Subject to the ability of the class, using what the pupils learnt in the first lesson about scale ask then to *draw and construct their buildings at a scale of 1:100 or 1:50*.

EXTENSION TOPICS

Urban sketching—Taking time to observe your environment and capture it in a sketch can be very relaxing. It also builds skills and confidence. Share with the class the output of some online urban sketching groups or artists from around the world. There is an urban sketching group in Aberdeen and some well-known artists and architects have sketched buildings in the city. Make time for the class to sketch once a week. If going on a school trip, take sketch pads and pencils and record the day with a sketch.

4.4—In proportioning their buildings Georgian architects often referenced the *'golden ratio'*, which it was felt gave aesthetically pleasing proportions. The ratio has a close connection with the Fibonacci sequence and can be found in nature. Activities exploring the golden ratio, Fibonacci sequence and the Fibonacci spiral could form a whole lesson in itself, or you may wish to introduce the principles and explore how they were applied to the plans and elevations of some famous Georgian buildings. ❊

LESSON 4

NEOCLASSICAL ARCHITECTURE

Pupil Section

During the Georgian period, as well as the layout of the town changing, the style of many of the new buildings built around the city also changed. The architects of the time looked back to the classical architecture of ancient Greece and Rome, which used geometry, symmetry and proportion. Neoclassical means 'new' classical. In Ancient Greek 'neos' means 'new'.

4.1 *Why did a Greek temple end up in Aberdeen?*

Take a look at this illustration and the photograph over the page of the Music Hall in Aberdeen.

- What adjectives would you use to describe it?
- What materials do you think have been used to make the building?
- How does it make you feel looking at it?
- Are you aware of any other buildings in Aberdeen that may look similar?

It was designed by Archibald Simpson in 1820 and built in 1822.


MUSIC
HALL
ABERDEEN
PERFORMING
ARTS

It was originally built as the city's Assembly Rooms, where well-off citizens could meet and socialise. It is on the corner of Union Street and Silver Street (leading to Golden Square) and is identified on the 1810 plan from the last lesson as a proposed building labelled 'Public Rooms'. Simpson design it in the Neoclassical architectural style. The style of Neoclassicism was seen as grand, sophisticated and associated with civility, law and order.

Think back to the drawing of the old housing at Putachieside from the previous lesson. How does it differ from the Neoclassical Music Hall?

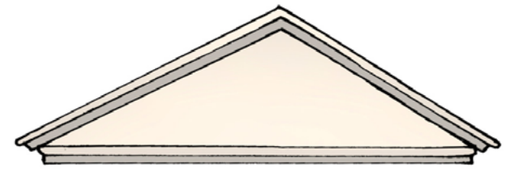
4.2 *Sketching buildings*

Neoclassical buildings are both simple and very complex. They are composed of very simple shapes but a lot of thought went into the different elements and in the way these are put together. Sketching a building requires us to look at the details and the proportions and can be a great way of learning about architecture.

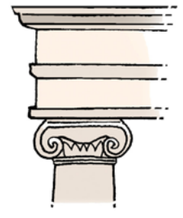
The following table describes different elements of the Music Hall's façade (the front of the building). These will form the main components of your sketch of the Music Hall.

Anthemion—A palmette or anthemion (from the Greek for a flower) is a pattern that looks like radiating petals of a flower.

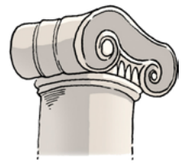
Pediment—Triangular upper part of the front of a building.



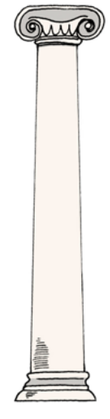
Entablature—The structure that sits above the columns.



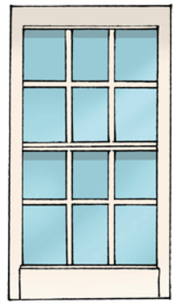
Capital—The upper part of the column which often reveals a column's style, history and the location it's been influenced by.



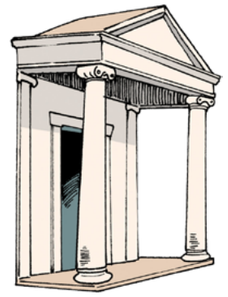
Iconic column—Often slim column with a curling capital, it's said to represent the female body.



Step by step how to draw the Music Hall



Casement windows—Often rectangular in shape with divided sections, the windows are commonly symmetrical and have straight lines. Within these the glass slides up and down inside the casement to open and close.



Portico—Roof supported by columns, often a building's porch.

Activity—following the instructions draw the front of the Music Hall, building up your sketch from an outline to a drawing with shadows and texture.

4.3 *The classical orders of architecture*

The ancient Greeks developed several different architectural styles which they called 'orders'. These orders were a set of rules for architecture. Each of the orders had distinct features in their columns. The

three most recognisable include the Doric, Ionic and Corinthian orders.

Take a look at the following columns opposite:

- What do the three orders have in common?
- What is different about each order?
- Looking at the Music Hall can you identify what type or order is used?

4.4 *Symmetry*

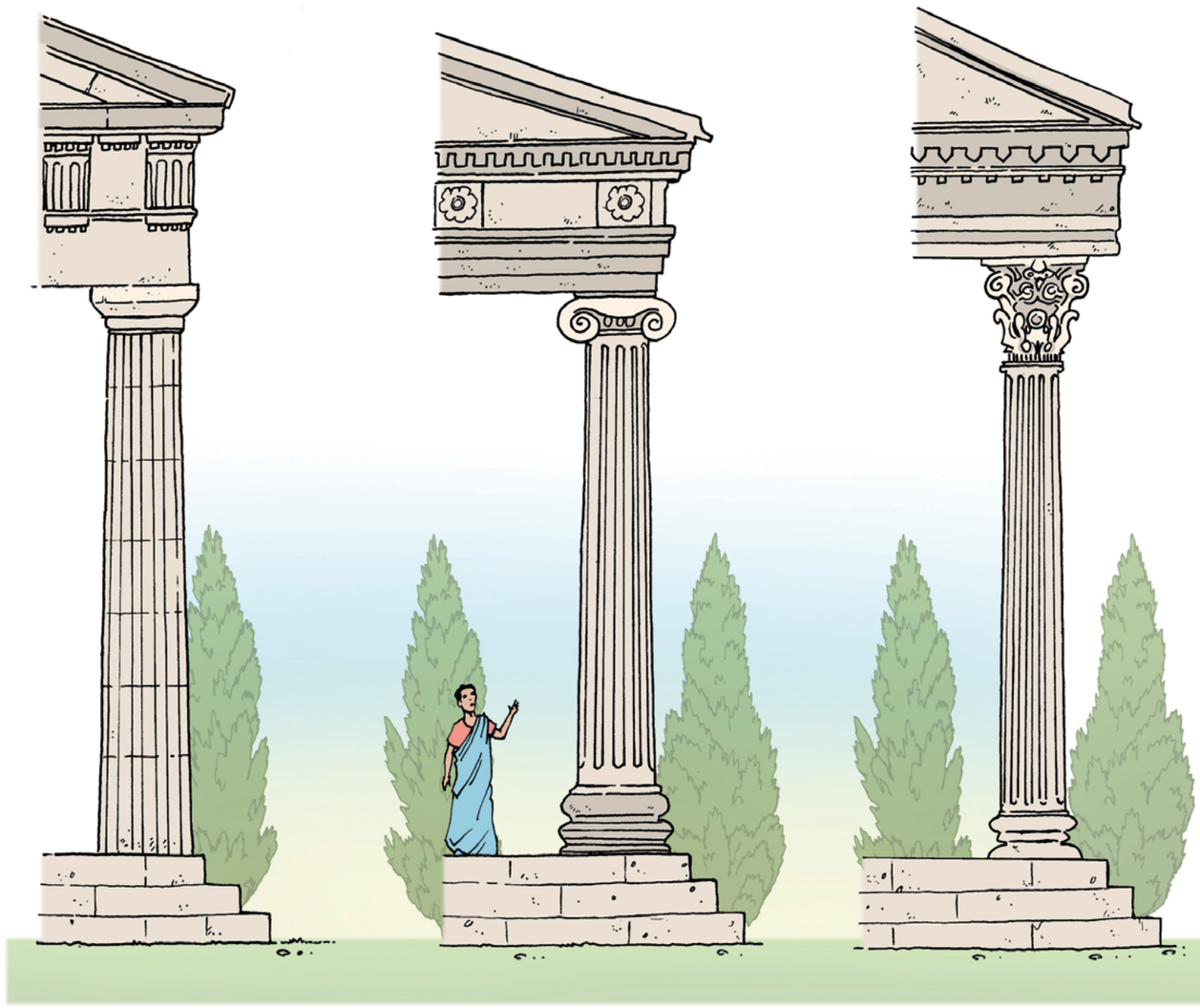
Using the Neoclassical façade of the Music Hall you have drawn, take a piece of paper and cover half of the picture of the Music Hall, now move the paper over to cover the other side. What do you notice about the two sides?

Georgian architects used symmetry in their designs. The buildings were balanced and pleasing to the eye. Important features such as grand entrances or impressive roof features could be better emphasised. They looked reasoned and ordered. The controlled symmetry was in contrast with the more random architecture of pre-Georgian Aberdeen.

Can you find any other lines of symmetry on the building or within the geometric shapes on the Music Hall façade?

4.5 *Designing a Neoclassical building*

From everything you have learnt about Neoclassical buildings and their features your challenge is to design and create a model Neoclassical building of your own. You should think about the ideas of



The three most recognisable orders of column.
From left to right: Doric, Ionic, Corinthian

symmetry, shape, line and symbolism in your building. To begin with it's useful to design using a floor-plan and the front elevation (the front wall of building).

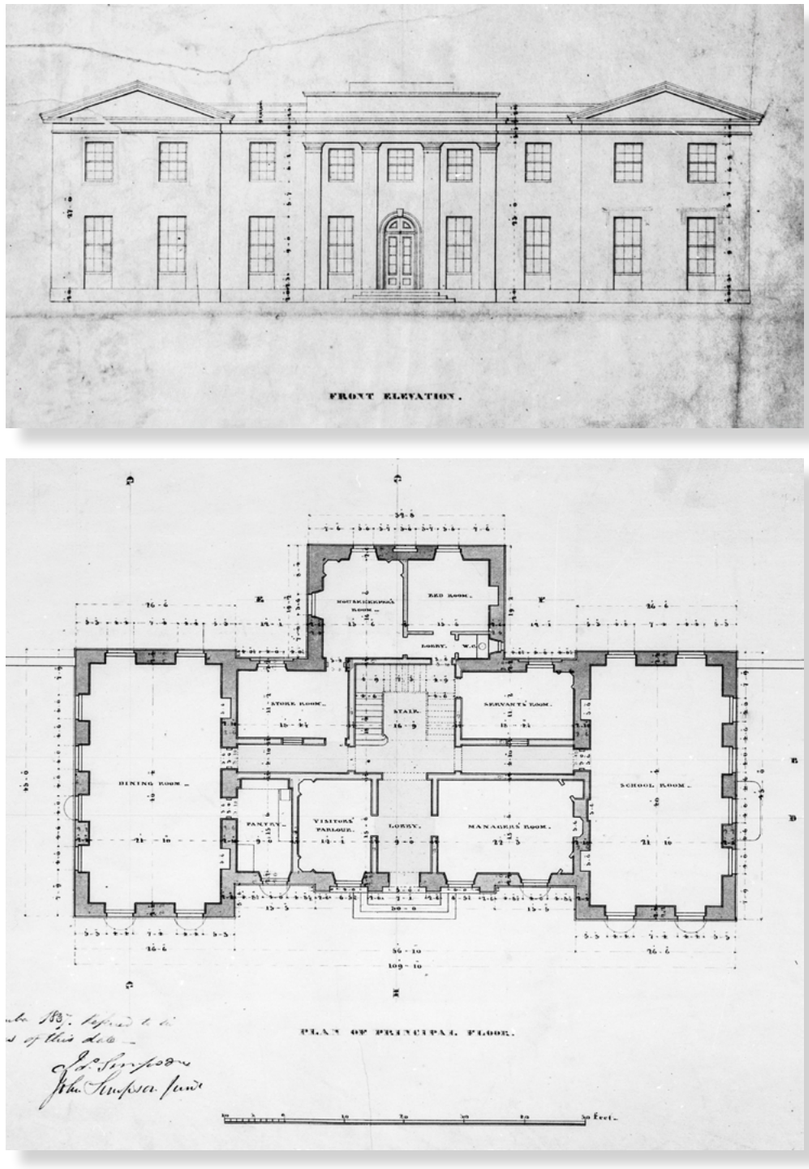
Think about these questions when you design your building:

- What is your building to be used for?
- Will your building have any columns? If so, which of the classical orders will you use?
- What geometric shapes will you use in the design of your building?
- How will you incorporate lines of symmetry within the building?

4.6 *Constructing a Neoclassical building*

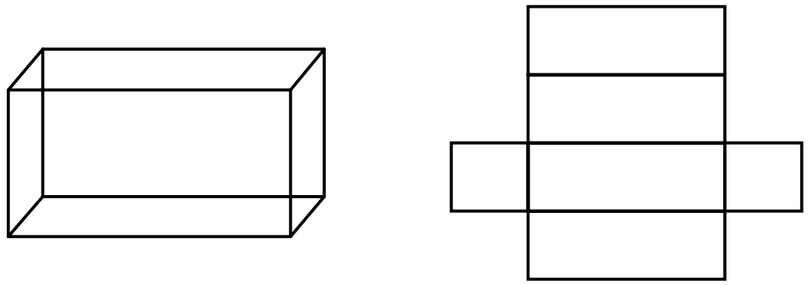
Using the two-dimensional sketches of your Neoclassical building, construct a three-dimensional model of it using either the nets provided other construction materials classroom. Your model, in plan, should be no larger than a piece of A4 paper. This will help to keep all the models a similar size and scale so they can be arranged into a street later.

You may wish to refer to or use the following nets to turn your 2D drawings into a 3D model.

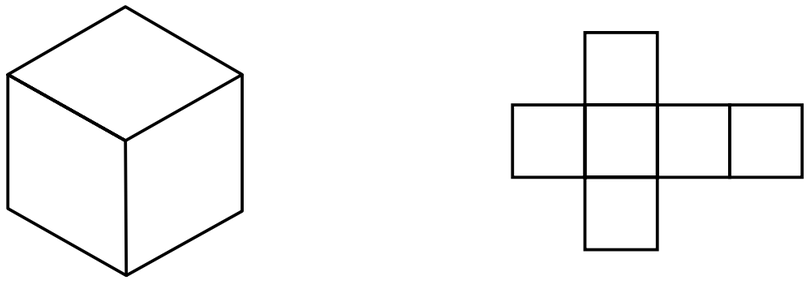


Floor plan and elevation.
Mrs Emslie's Institution (for orphans and destitute girls),
now part of Harlaw Academy

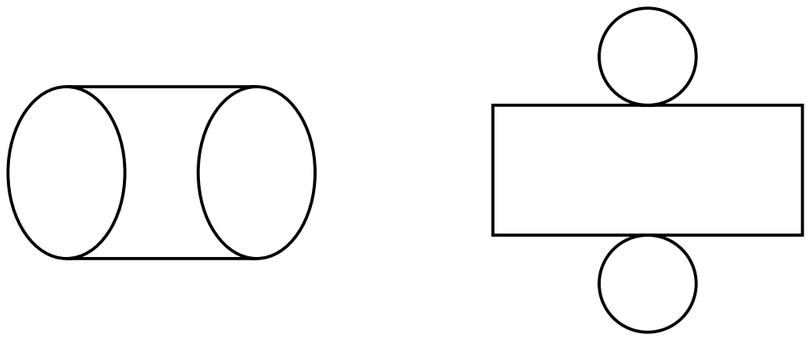
4 rectangles, 2 squares/rectangles—*Cuboid:*



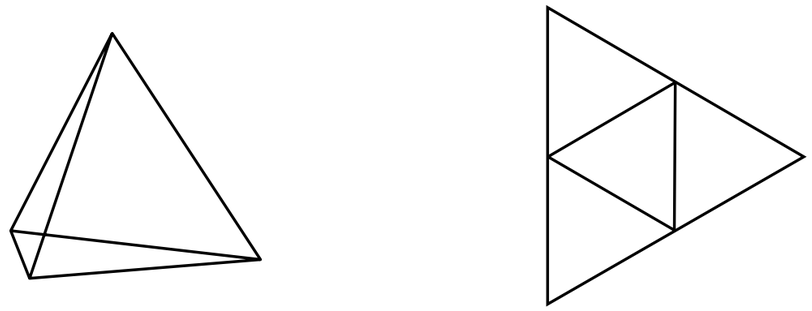
6 squares—*Cube:*



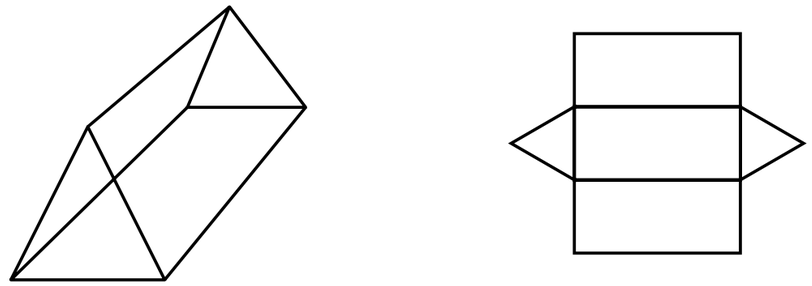
1 rectangle, 2 circles—*Cylinder:*



4 triangles—*Triangular-based pyramid (tetrahedron):*



2 triangles, 3 rectangles—*Triangular prism:*



4.7 *Designing a Neoclassical street*

Once your class has finished making the 3D models arrange them on the classroom floor so that they form streets or small city. Think about the arrangement and size of the streets, where different buildings will go and whether your new town needs any other features such as parks or markets.

Based on what you have learnt about Georgian town planning where will you place your building and why? ❊

LESSON 5

UNION BRIDGE

Teacher Section

EXPERIENCES & OUTCOMES

Expressive Arts

I can develop and communicate my ideas, demonstrating imagination and presenting at least one possible solution to a design problem. EXA 2-06A

Health and Well-Being

By reflecting on my own and others' work and evaluating it against shared criteria, I can recognise improvement and achievement and use this to progress further. HWB 2-24A

Mathematics

I can apply my knowledge of number facts to solve problems where an unknown value is represented by a symbol or letter. MTH 2-15A

I can accurately measure and draw angles using appropriate equipment, applying my skills to problems in context. MTH 2-17B

Technology

I can extend and enhance my design skills to solve problems and can construct models. TCH 2-09A

I can extend my knowledge and understanding of engineering disciplines to create solution. TCH 2-12A

INTRODUCTION TO THE LESSON

In this lesson pupils will learn about bridge engineering, through practical experiments.

AIMS OF THE LESSON

- Pupils will develop an understanding of the main types of bridge design and of the tensile and compressive forces that they are subjected to.
- Pupils will be presented with design challenges and constraints and invited to learn through trial and error.
- Pupils will develop their understanding of how algebra can be used to solve problems.
- Pupils will have a greater understanding of the (often hidden) engineering that enabled the construction of Union Street.

NOTES ON THE LESSON AND MATERIALS REQUIRED

This topic uses an NLS online resource as well as the following materials:

Straw bridges:

- Paper drinking straws- 80 per group.
- Tape (masking or Sellotape).
- Scissors.
- Paper cup (one per group).
- Ruler (one per group).
- Weights—a set of small objects of equal weight (e.g. a handful of 5p pieces).

Noodle box arches:

- Cardboard noodle poxes (approx. ten per group—subject to dimensions).
- Double-sided tape.
- Additional cardboard for the base—the width of a noodle box and length to be determined subject to box dimensions (estimated at about 70cm long- could be formed from a couple of pieces taped together).
- Protractor.

EXTENSION TOPICS

The suggested extension topics require additional resources, which are readily available and low-cost.

NOTES ON THE CONTENT OF THE PACKS

The following notes supplement to the content in the pupil's pack and offer tips and further information for teachers. They are set out under the headings in the lesson content.

5.4 *Calculating the number of voussoirs needed:*

The following angles and dimensions are for example only. They are based on cardboard noodle boxes and may differ from the dimensions of the boxes or other materials you are using.

If the pupils calculate in the first instance using the example then they will be better placed to then take measurements off the boxes they are using and calculate for those.

To calculate the number of boxes required to form a semi-circle the children will need to calculate the angle that is formed when the two tapered sides of the boxes are extended until they meet (creating a triangle). In the

example, there are two known angles of 81 degrees. The angle at the tip of the triangle that has been formed is therefore 18 degrees.

X = 180-(2 x 81)

X= 180-162

X = 18

A semi-circle has 180 degrees, it therefore requires 10 (10 x 18 degrees gives 180 degrees) noodle boxes to create a semi-circular arch.

From this we can calculate the radius of the arch. Twice the radius gives us the width of the base we need to cut for our noodle box arches.

Calculating the radius requires an understanding of trigonometry. Subject to the level the pupils are working at, it may be appropriate talking them through the example as a way of introducing trigonometry. It will in any case be necessary to calculate the radius based on the boxes your class is using, to know what width to make the base plate for the arches.

In the example, the long side of the noodle box is 11cm. Drawing a line at 90 degrees from the centre of the long side to the opposite tip of the triangle gives a triangle with the following properties:

- Length of the opposite side 5.5cm (half of 11cm).
- Angles of 90, 81 and 9.

The radius of a semi-circular arch is the length of the hypotenuse. This can be calculated using Sin (9)

Sin (9) = 5.5 over X

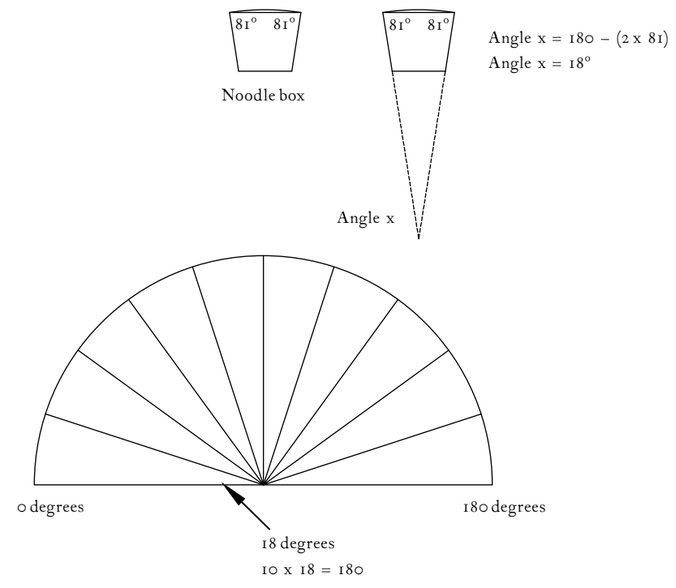
Sin (9) is approx. 0.1564

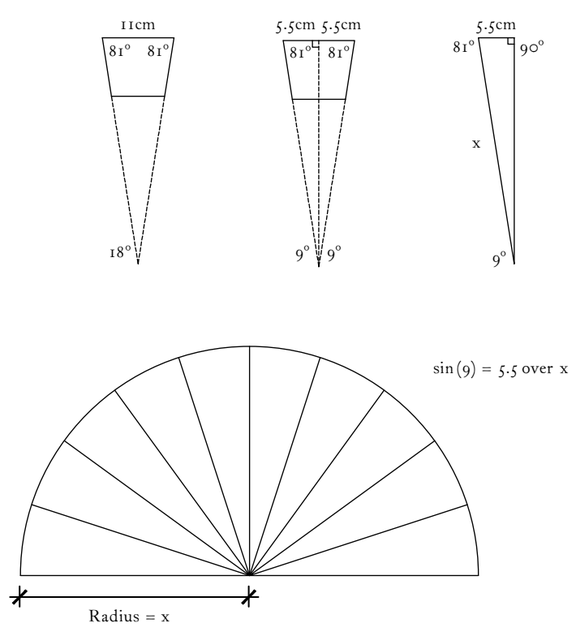
5.5 over sin (9) = X

35.1 = X

The radius is 35.1cm.

The width of the base is the diameter (2 x R) which is 70.2cm.





EXTENSION TOPICS

Bridging the gap

Extension topic—you can follow the route on the Denburn through the Aberdeen City guide.

https://www.aberdeencity.gov.uk/sites/default/files/2021-12/Aberdeen%20Denburn%20Trail.pdf

Drawing on learning in previous lessons around reading old maps, can the pupils identify when the burn was covered over in various places? How has the covering over of the burn changed how people use the areas it passes through or under? What environmental impacts may have resulted in covering over a large section of the Denburn?

Bridge engineering- tension and compression exercise

Pupils can explore tensile and compressive forces in the main bridge designs through a number of activities. Many are available as online resources.

Simple classroom experiments include:

Forces

- *Compressive*—ask the pupils to push on opposite ends of the straws or jelly sweats (such as Squashies). What happens if they cut the straw shorter (reduced the span of the beam)?
- *Tensile*—ask the pupils to pull outwards on paper straws or jelly sweats and describe what happens.

Bridges

- *Beam bridges*—span a gap (between books) with a kitchen sponge or a marshmallow bar. Mark vertical lines on the 'beam' so the pupils can see the forces acting on it. Ask them to load the beam with some weight (it might be simply pushing on it gently) and then observe the compressive forces on the top (the lines will come together) and the tensile forces on the underside) the lines will spread apart as the object stretches).

- *Arch bridges*—take a piece of cardboard or a long flat chewy sweat bar (e.g. Moaom) and gently form an arch in it. For the sweat bar you might do this by first creating a beam bridge with it (resting it over a gap between two books or Lego abutments) and loading it until the beam fails. Ask the pupils to place their arch on their table and add a small weight to the top of it (again, this might simply be applying a light force with a finger or pen). The arch will spread and collapse. Now ask them to do the same but this time place the arch between two abutments. These might be some books or Lego towers stuck to a board. With the ends of the arch held by the abutments their arch will take a greater load.
- Suspension bridges—using some tall, weighted objects (heavy, hardback books or cereal boxes with some weight in them) tie a string to each object and then move the objects apart so the string has a slight sag at most. Apply a force (a gentle hand movement) to the string and observe the impact of the force on the string and the 'towers'. Then repeat the experiment but this time rest the string on top of the 'towers' and anchor it back to a point on the ground beyond the tower (put some books on it or ask pupils to be the anchors that hold the string to the ground). The bridge should be able to support a greater load than the first test.

Calculating the span

Calculating the circumference and volume of the arch—having calculated the diameter (span) of the arch using trigonometry (whether themselves or with the teacher help) can the pupils use the information to calculate the circumference and volume of the arches? The circumference will be a very close approximation, and based on the radius of the semi-circle, as the noodle boxes do not have curved lids.

For volume of boxes that are tapered on all sides such as the noodle boxes the calculations are more complex than if the voussoirs were angled on just

two sides. The pupils can calculate the volume of their arches by finding the volume of one noodle box (the volume of a truncated pyramid) and multiplying it by the number of boxes used.

You might also wish to set the pupils some challenges to calculate the volume of arches with more traditional voussoirs (angled on just two sides). Example—given certain dimensions of a semi-circle arch bridge how many brick voussoirs (of known dimensions) are needed to build the arch? ❊

LESSON 5

UNION BRIDGE

Pupil Section

Union Bridge was built between 1802–5 to a design by the engineer Thomas Fletcher. The bridge was incredibly important in the development of Union Street as it bridged the Denburn Valley and replaced many medieval winding streets. It helped to open up new areas of the city for development.

Union Street, which passes over the bridge, was named after the 1801 union of Great Britain and Ireland. As we learnt in an earlier lesson, the construction of the street required the removal of the top of St Katherine's Hill. To build Union Street straight and level, Georgian engineers also had to design structures to bridge the ancient streets and a valley below. Union Bridge is the largest of these structures.

Union Bridge spans a width of 130 feet (or about 40m) and is constructed from granite, which was readily available from the many granite quarries in the city and wider Aberdeenshire. The original bridge was 40 feet wide (or about 12m). It was widened in the early

1900s with the addition of steel arch-ribs to each side. In the 1950s the space above the railway line and road to the south side of Union Bridge was built over with shops, meaning it is no longer possible to see that side of the bridge. It is possible to identify these changes on the Ordnance Survey maps that we looked at in a previous lesson. Today only the north side of Union Bridge (facing Union Terrace gardens) is visible.

Looking at the drawing on Union Bridge opposite, what difficulties do you think people faced trying to build it?

5.1 *Bridging the gap*

A bridge is a structure that spans an obstacle, such as a river, a valley or a canyon. They can also be built to span man-made obstacles such as roads and railways. In spanning the obstacle, the bridge allows passage over the obstacle without blocking what runs underneath.

Union Bridge was built to span the Denburn valley, which included the Denburn. Today the bridge spans over a road and railway line, but the Denburn is still there running through a culvert from Mackie Place to the harbour.

Working in small groups, your challenge is to design and build a bridge that spans a gap of 40cm between two desks. The objective of the bridge is:

- The bridge must span the gap and support as much weight as possible.

Union Bridge in 1803

Engineers often work with constraints. Your constraints are:

- Your bridge must be able to support a paper cup in the middle of the bridge (you will test the strength of your bridges by adding weights into this cup).
- Your bridge must sit on the tables at the side (it cannot be stuck or taped to the tables).
- The only materials available to you for building the bridge are 80 drinking straws, scissors and tape.

Begin by each pupil sketching a bridge design on paper. You might choose to draw it in plan and elevation or in perspective (showing it in 3D). Your sketches must clearly convey the design to the other people in your group.

Once everyone in your group has a design they are happy with discuss the designs as a group. Which design do you think will best meet the objective and why? Review the objective and constraints and, if necessary, refine your group's chosen design. It may be that the final design has features from a number of different designs.

Using no more than 80 drinking straws, scissors and tape work in your group to build the chosen design. You have 30 minutes to complete the build and you may not test the bridges over the gap in this time. Instead mark out a 40cm line on your working surface and remember the bridge must be wider than the gap.

Top Tip—The more tape you use the heavier your bridge will be. The bridge must support both its own weight and the weight of the cup with added weights.

When all the group have constructed their bridges take it in turns to test the bridges over the gap. Each group should place a paper cup in the centre of their bridge and slowly add weights into the cup until the bridge fails. These weights could be coins or objects in your classroom, but they must be equal weight (e.g. all the coins should be the same denomination). The winning bridge is the one that held the most weight before collapsing.

As a class discuss:

- Which bridge held the most weight?
- Where and how did the bridges first give way?
- If doing the same exercise again, how would each group improve their bridge design?

5.2 *Bridge engineering—tension and compression*

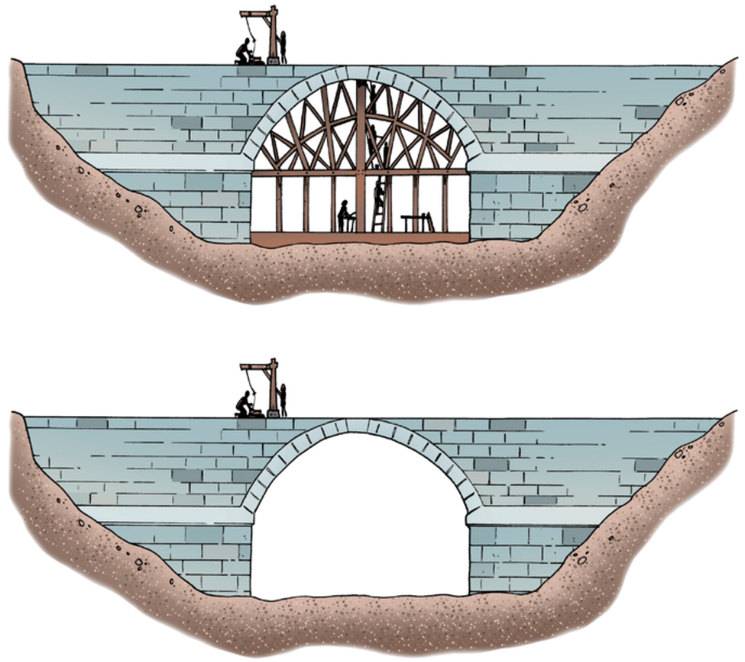
Today we have the technology and materials to build bridges that span long distances between supports. The three main bridge designs are bean or truss, arch and suspension. Whether a beam, truss, arch or suspension bridge they are all subject to the same forces: compression and tension.

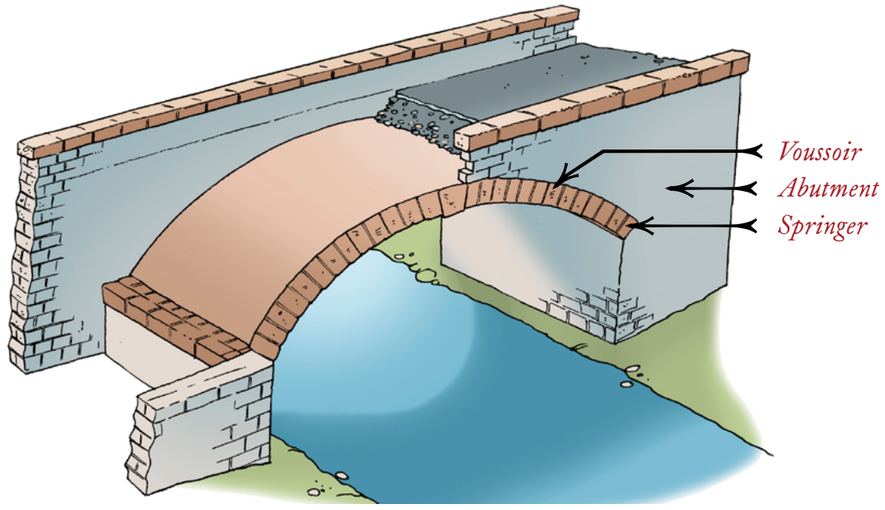
Compression is a force that acts to compress the thing it is acting on.

Tension is a force that acts to lengthen the thing it is acting on.

Beam or truss bridges—Simple beam bridges comprise a horizontal element resting on supports at each end. A log spanning over a burn is an example of a very simple beam bridge. When you walk over the log your weight pushes down on it. The top of the log is under compressive forces while the underside is subject to tensile forces. If the log is not strong enough to take your weight it will fail on the underside and snap in half. The underside of the log is stretched under the tensile forces, until it snaps. The longer the span the weaker the beam becomes. A variation of a beam bridge is a truss bridge. By creating a beam out of trusses, or triangular units, the bridge is stronger and can span further.

Arch bridges—Union Bridge is an example of an arched bridge. This type of bridge has a curved structure called an arch. The arch helps distribute the weight and the loading on the bridge by transferring it to the ends of the bridge, called the abutments. The abutments distribute the load to the ground and prevent the arch from spearing out. The stones of the bridge stay together by the force of their own weight and the compression transferred between them. The aim of an arch bridge is to carry the loads in compression, without any tensile loads. The span and the shape of the arch have an impact on this. A very shallow arch will be subject to more tensile forces than a more curved arch.





The parts of a bridge

The arch allows the bridge to span longer distances than some other designs and it can be made from natural materials such a stone.

Suspension bridge—Suspension bridges have their deck (the footpath or road) hung from vertical cables (called suspenders or rods) that are in turn hung from main cables. The main cables are supported on towers and anchor points at the ends of the bridge. The cables are in tension and the towers are in compression. The weight is transferred by the cables to the towers and in turn to the anchor points and then finally to the ground.

- Thinking back to the straw bridges, what design were they?
- Were they all the same or did some groups used very different designs from others?
- What was the greatest factor in dictating the designs?

5.3 *Exploring arches*

Arches come in many shapes and sizes but they all have in common key components (see illustration previous page). Understanding these components is critical in understanding how arches work and why they are so strong, even when made from lots of relatively small stones held together without any mortar.

- *Abutment* or *pier*.
- *Voussoirs*—the wedge-shaped units that form an arch.
- *Springer*—the first voussoirs.

- *Keystone*—the highest, central wedged-shaped block in an arch.
- *Sofit*—the underside of the arch.
- *Spandrel*—the area on either side of the arch, between the top of the arch and the side of the arch.

5.4 *Building noodle box arches*

Making a model arch from cardboard is easy and requires very few tools or materials.

We used noodle boxes in this example, but you could also make the voussoirs out of strips of cardboard. For a colourful arch why not use the free paint sample cards (from paint and DIY stores). The different colour shades are a handy marker for folding into voussoirs. Your teacher will have separate instructions for making arches from paint sample cards.

Calculating the number of voussoirs—We will be building semi-circular Roman arches. Using the dimensions and angles on the example given below can you calculate the number of voussoirs you will require to construct a semi-circular arch?

The answer in the example is a whole number. When you calculate using the dimensions of your noodle boxes you may find it is not a whole number. Round the number up or down to the nearest whole number, for an approximately semi-circular arch. See opposite.

Calculating the span—Can you calculate the width the base needs to be for a semi-circle arch? The width, or span, of the arch is the diameter

of the semi-circle. This calculation uses trigonometry which you may not be familiar with. Whether working it out yourself or with the help of you teacher, you will need the dimensions and angles of the boxes you are using to calculate the width of the base. What is the long length (the lid of the box) and what is the angle the lid makes with the tapered side of the box.

You will need:

- Noodle boxes or paint sample cards, for the voussoirs.
- Double-sided tape or glue.
- Card (or extra paint sample cards) for the base.

First make the voussoirs. Noodle boxes are already tapered to give the wedge shape of voussoirs. If using paint sample cards your teacher has separate instructions.

To stop the arches spreading, the bottom two voussoirs need to be anchored to a base. The width of the base was calculated above, using trigonometry. The noodle box arch has a cardboard base, which makes it easier to move the completed arches and create larger bridges with you classmates. Make sure the base is the same depth as the voussoirs, as this will make it possible to put lots of arches together to create larger models later in the lesson.

If you calculated that you need an even number of voussoirs to create a semi-circular arch, then cut one of the voussoirs in half (you may need to add some tape to the box before cutting it, so it keeps its shape). These half voussoirs will be the first blocks of your arch.

A noodle box arch

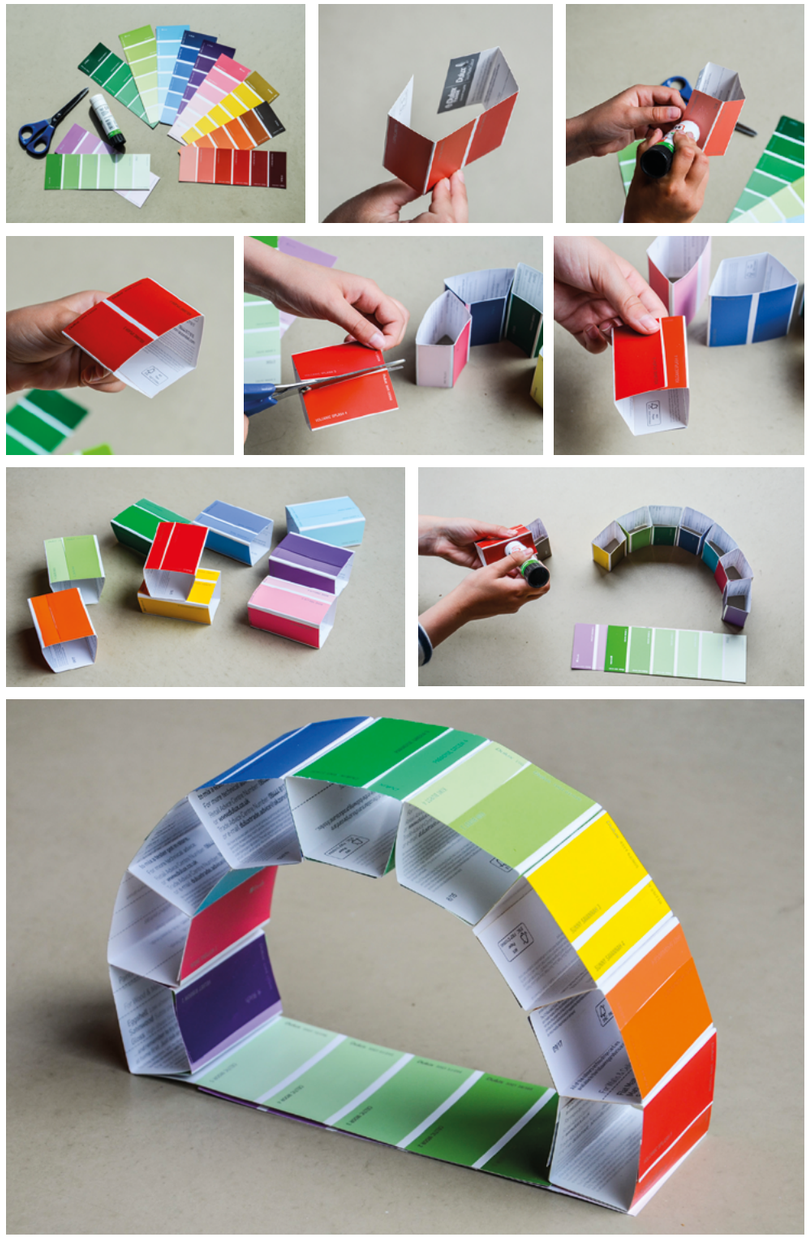
This ensures that you will have a central a key stone in your arch. If you calculated that you need an odd number of voussoirs then you do not need to cut one, as the odd number means you will have a central key stone.

To construct our noodle box arch we used double-sided tape between each voussoir. The bottom voussoirs were fixed firmly to the base with tape or glue.

Top Tip—stone bridges are made with temporary timber formwork to support them. Once all the pieces of the arch are in place the formwork can be removed and the arch will remain in place. When building a lightweight model arch it is often easier to build the arch on its back and then lift it up once all the voussoirs are firmly stuck to each other.

Having made your noodle box arch, gently apply weight to the top of it—push down with your hand very gently (you don't want to crush the cardboard)—then describe the forces that you can feel. You might wish to draw the forces on the arch using a marker pen.

- What do you think would happen if the first voussoirs were not fixed to the base?
- What would happen to the arch if one voussoir was damaged and fell from the arch ?



A paint sample card arch

5.5 *Noodle box bridges and vaults*

Having created your arches individually or in pairs, now arrange them as a class on the floor of your classroom to recreate Union Bridge. The arches to the east and west of the main arch of Union Bridge are smaller than the main arch, but your arches will be the same (assuming you have all built semi-circular arches with the same size noodle boxes).

Thinking about the width of Union Street, how many noodle box arches will you use to create the width of the bridge? If you have spare cardboard then add a deck to the top of your bridge, so carts (or cars) can travel over it. Try loading the bridge with objects from around the classroom.

By lining the arches up next to each other you will have created a barrel vault on the underside of the arch. What length of barrel vault can you create if you line up all the arches your class has made? There are spaces under Union Street that have barrel vaulted ceilings, formed by arches supporting the street above. Are you familiar with the railway arches on South College Street in Aberdeen?

Using Google Street View, or from your own knowledge of the buildings and structures in Aberdeen, can you find any other arches that you could try to recreate in the classroom with your noodle box arches?

What about online research into the use of arches by the Romans? Can you use additional cardboard strips on top of a row of arches to

create a two-tiered viaduct? As you build structures with your arches think about the materials used in the original arches you are trying to recreate and the forces involved in the engineering of the structures. ❊