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| **Lesson Four: Bronze Working** |
| Lesson Four is all about bronze working. The lesson focuses on a few different elements in creating bronze, beginning with a video demonstration of how bronze objects are made. It then moves on to discussing alloys - both what they are and how they are created - and finishes with a chocolate casting exercise as an experiential learning task to mirror the process of casting bronze. It is an enjoyable lesson (especially the chocolate casting) but it does need a little preparation as it requires some extra resources.  |
| **Curriculum Links - Social Subjects (People, Past Events and Societies)** |
| Experiences and Outcomes | Benchmarks |
| **I can use primary and secondary sources selectively to research events in the past. SOC 2-01a****I can interpret historical evidence from a range of periods to help 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****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****I can discuss why people and events from a particular time in the past were important, placing them within a historical sequence. SOC 2-06a** | * **Uses both primary and secondary sources of evidence in an investigation about the past.**
* **Places an event appropriately within a historical timeline.**
* **Describes at least two ways in which past events or the actions of individuals or groups have shaped Scottish society.**
* **Describes and discusses at least three similarities and differences between their own life and life in a past society.**
* **Contributes two or more points to the discussion (in any form) as to why people and events from the past were important.**
* **Places those people and events on a timeline.**
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| **Wider Curricular links** |
| **Science (Materials):**By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. **SCN 2-15a****Social Studies (People and the Environment):**To extend my mental map and sense of place, I can interpret information from different types of maps and am beginning to locate key features within Scotland, UK, Europe or the wider world. **SOC 2-14a****Technologies (Awareness of Technological Developments; Past, Present and Future):**I can investigate how product design and development have been influenced by changing lifestyles. TCH 2-05a |

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| **Learning Objectives** |
| I can identify the different properties of materials. |
| I can describe the process of casting metals. |
| I know that an alloy is a mixture of metals. |
| I know that ancient peoples developed trade routes. |
| I can use a map to locate places within and outwith Scotland. |

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| **Resources and Suggested Reading** |
| **Required Resources - Supplied in the boxes or from ARCH website** |
| Objects: Box 1 and Box 2 objects, particularly those of bronzeInformation Sheets: CT Bronze Casting, TimelineLesson Resources: Object Summaries, Object Picture Set, Colour Mixing Resource Sheet, Bronze Casting Quiz QuestionsOther Resources: ARCH Bronze Age Metalworking video([link](http://www.archhighland.org.uk/experimental-archaeology.asp))  |
| **Additional Required Resources** |
| Red and yellow poster paint, paint pallets, paint brushes, chocolate, brown sugar, containers, objects for mould impressions, map of the British Isles. |
| **Essential Reading - Information sheets supplied in the box or from ARCH website** |
| CT Bronze Casting |
| **Suggested Additional Reading - Information sheets supplied in the box or from ARCH website** |
| Object sheets: Bronze Halberd - as cast, Bronze Flat Axes (Box 1) Bronze Swords, Bronze Sickles, Bronze Gouges, Bronze Spear, Bronze Sunflower Pin (Box 2)When? Bronze Age |

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| **Introduction** | **20 minutes** |
| **Timeline** (15 minutes) | Resources: Objects: All Box 1 and Box 2 objectsOther Resources: Timeline, Object Summaries |
| * This task is completed with objects from Box 1 and 2.
* It can be revisited as a recap if this activity has been completed as part of a previous lesson.
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| Lay out the materials around the classroom and arrange the pupils into pairs. Hand out the objects between the pairs. Have the pupils discuss what the object is and ask them to feedback their thoughts to the class.Lay out the timeline on the floor. The pupils are then to discuss when in history their object dates from. Once they have decided they place the object at that point on the timeline (remember to go over the different eras displayed on the timetable and give a little information about them).An object summary sheet has been included in the box; use this to rearrange the objects into the correct order. |
| **Materials** (5 minutes) | Resources: Object picture set, cut into individual objects |
| * This activity can be used as a recap if already completed within a different lesson.
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| Form the pairs into small groups of three or four. Hand out the pictures of the objects to each group. Ask the groups to split the pictures between them - so each member of the group has to participate. Ask the pupils to categorise the objects into groups. The categories you use will depend on the ability of the class; there are three differentiated suggestions below.Split the objects into:* Metal and non-metal objects.
* Bronze, stone & flint and ceramic objects.
* Bronze, stone & flint, Iron and ceramic objects

Ask the class ***What is bronze?***They should identify it as a type of metal; however, some may go further and identify it as an alloy (metal created by combining multiple metallic elements). |

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| **Main** | **1 hour & 20 minutes** |
| **Bronze Casting Workshop** (10 minutes) | Resources: ARCH Bronze Age Metalworking video ([link](http://www.archhighland.org.uk/experimental-archaeology.asp)) |
| * This video was created from footage taken of a bronze casting workshop organised by ARCH as part of the *Experimental Archaeology:* *Learning about Technologies in the Past* project. It is a demonstration of how bronze casting works. Neil Burridge is the speaker and is very experienced working with metal.
* You can watch the entire video as part of the lesson. However, timestamps have been provided as a guide to the information essential to this lesson.
* Producing high quality sound in the venue was difficult so it may be worth warning pupils that they will need to concentrate to catch all the information and recap as necessary.
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| Start the video at **1:29** explaining that Neil is discussing how the technology of metal working took thousands of years to travel from Syria - its point of origin - to the British Isles and then to Scotland.Pause the video at **2:05** and ask the class ***What is the man in the blue t-shirt doing behind the speaker?***He is using the bellows to provide oxygen to the fire and in doing so is controlling the heat of the fire (his name is Matt Knight, the curator of Bronze Age at the National Museums of Scotland). Ask **W*hy do they need to control the heat of the fire?***Explain that the fire is used to melt the raw materials. As a *think-pair-share*exercise ask the children ***Why might the “secret” of metal working take so long to travel from Syria to the British Isles (i.e thousands of years)?***Share their answers as a group and then continue the video to find out - pause and recap the answer with the class if you feel it is necessary. *(As a side note - the bronze Neil worked with on the day was 12% tin).*Finally pause the video at **5:10**. As another *think-pair-share*exercise ask the class to summarise what they have just heard. The key points are:* Bronze is made from copper and around 12% tin.
* It took a long time for the technology of metal working to progress across Europe.
* Casting blades began with short daggers, progressed to longer dirks and then eventually progressed to rapiers.
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| **Creating Alloys** (30 minutes) | Resources: Objects: Bronze swords, Bronze gouge (Box 2)Lesson Resources: Colour Mixing Resource Sheet Other Resources: Red and yellow poster paint, paint pallets, paint brushes |
| * An alloy can sometimes be counterintuitive for pupils. Therefore, the below activity is designed to frame it in terms most will be able to easily understand.
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| Explain that bronze is an alloy - ask the class ***What is an alloy?***(a metal created by mixing two other metals. In the case of bronze it is a mixture of copper and tin).Explain that when creating an alloy it is essential to get the ratio of the mixture right. To demonstrate this, arrange the class into pairs. Give each pair a paint pallet with some yellow paint and some red paint (poster paint is by far the best to use in this activity). Give the pupils the Colour Mixing Resource Sheet. Explain that orange represents bronze, yellow represents copper and red represents tin. The class are to mix the red and yellow to try and get as close a match as possible to the shade of orange at the top of the sheet. Have the class make multiple attempts and encourage them to approach the task methodically. If a pair manages to mix the colour early on, see if they can repeat it.Ask the pupils to paint each attempt into one of the boxes. Working in pairs will hopefully mitigate any issues such as colour blindness etc.When each group has at least made a few attempts, ask them to choose, as a pair, the colour that is closest to the orange at the top of the page.Explain that the shades of orange that are too dark are like bronze with too much copper in it and will therefore be a little bit too soft to cast an item like a sword. The shades that are too light are like bronze with too much tin in it which won’t pour as well during casting. The ratio of the mixture makes a big difference to the end product.Show the following objects:* Bronze Swords
* Bronze Gouges

Have the children pass the objects around the class and show them, specifically, the casting flaws on these objects. These are areas where the casting wasn’t entirely successful. They could be caused by trapped air bubbles or the pour not working properly. The quality and mixture of the alloy can have an impact on the quality of the final product and so it is important to get it right. |
| **Copper, Tin and Trade** (10 minutes) | Resources: Map of the British Isles, Google maps |
| * This is a quick activity to show the distances involved in getting the materials to make bronze.
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| Display the map of the British Isles on the white board or use a print out. Have the class find Inverness on the map. Display google maps and click on Inverness and then click on Lands’ End in southwest England - this is where most of the British tin came from.This will display how long it would take to travel there with modern transport. If you click the little figure it will show you many hours it would take to walk the same distance. You could have the class work out how many days that would equate to as a quick maths exercise.Repeat the process for Ross Island, in Lough Leane, Killarney, Co. Kerry, Ireland explaining that this is where copper ingots were sourced from, although there are copper deposits in Scotland.Ask the class: ***Given that someone is not going to walk for two hundred hours to find tin, what does the use of bronze in the Highlands possibly prove to us?*** This is a difficult question and can be completed as a group discussion exercise if desired. The answer is that there was trade taking place in the British Isles which allowed the distribution of tin throughout. It is important to note that boats were the main form of transport over long distances, especially when trading. |
| **Chocolate Casting** (30 minutes) | Resources: Objects: Sunflower pin, swords (Box 2)Other Resources: ARCH Bronze Age Metalworking video ([link](http://www.archhighland.org.uk/experimental-archaeology.asp)), Chocolate, brown sugar, containers, objects for mould impressions. |
| * The actual chocolate casting element of this activity is optional. However, it is worth taking the time to complete as it always seems to go down well.
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| Show the ARCH Bronze Age Metalworking workshop video from **5:10**. This part shows the casting of a bronze sunflower pin used to attach a cloak, or secure a sword to one’s person (1 & 2) - both these objects can be found in Box 2 and are worth showing the class after the clip. There are two swords in the box; one has been left “as cast” and the other is an example of the finished product (although not sharpened) with a wooden hilt. It is worth noting the casting errors in the blade as it is likely this sword would have been melted down and made again, as the errors would have made it too weak to be used. The video finishes with a demonstration of the hafted axe from Box 1 being used.After the clip it is worth recapping the following information:* The bronze is heated to 1200 degrees centigrade.
* It is poured, in its molten state, into a mould usually made of clay, stone or compressed sand.
* The mould is then broken open and the object cooled.

*OPTIONAL*This activity is always fun but it may need a little experimentation beforehand to get it right. However, casting is a difficult process and as much learning is to be gained from failed attempts as well as successes.For this activity you will need sufficient chocolate for melting, containers and brown sugar. It is best completed in small groups or pairs if enough resources can be obtained.Fill a container with an inch, or two, of brown sugar. Smooth the sugar and press it lightly, do not compact the sugar too much. Press an object into the sugar to make an impression of the shape. This can be anything from a chess piece to a key or piece of lego - be careful to ensure food hygiene standards are maintained. Melt the chocolate thoroughly and pour it into the indentation. Leave to cool in a fridge or even a freezer.Remove the chocolate from the mould and rinse any excess sugar under a cold tap. The cast chocolate will most likely have taken an imperfect cast of the mould which is a common problem with metal casting. The consistency, the temperature of the alloy and the speed at which it is poured can all affect a cast.As a class, compare the chocolates with the bronze objects. You may see some similarities in the imperfections of the bronze objects and the air bubbles or rough surface of the chocolate.If the chocolates go completely wrong, make a show of re-melting the chocolate and trying again. Relate this to bronze casting as failed casts would be re-melted and reused.Be sure to explain to the class that while this is an experiential example of casting, the process of casting bronze is different in that it uses a complete mould and therefore items would be cast as one complete object (rather than the two halves you end up with in the chocolate casting task). |

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| **Plenary** | **20 minutes** |
| **Learning Quiz** (15 minutes) | Resources: Information Sheet: CT Bronze castingLearning Resources: Bronze casting Quiz Questions |
| * This activity is designed to share a lot of information and recap learning quickly in an interesting way. It consists of a quiz based on the information sheet provided with the lesson.
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| Split the class, if they are not already, into small groups of three or four. Number the pupils in each group from one to four. Ensure any struggling readers in each group are the same number.Place the CT Bronze Castinginformation sheet in three places around the room. Send the ones, twos and threes to the three different places of the room. The fours can be used to support any struggling readers in their group.Have the ones read the top two paragraphs, the twos the third and fourth paragraph and the threes read the last two paragraphs.After five minutes, have the groups come back to their tables. Complete the bronze casting quiz (supplied in the box or on the ARCH website). Each member of the team has read different information and so can contribute equally to the quiz. |
| **Favourite Fact** (5 minutes) | Resources: None |
| * The following is a quick activity to allow the pupils to reflect on the lesson they have just completed.
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| Ask the class to think, in silence and independently, about the following questions:1. **What was your favourite activity?**
2. **What was the most interesting thing you learnt?**
3. **What question would you ask Neil Burridge if you could?**

Share and collate the class’s responses. |

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| **Total Lesson Time: 2 hours**  |
| **Teaching notes** |
| 1. The bronze swords are objects that always go down well with any class and they may want to spend longer on them than planned in the session. It is worth having a really good look at the objects as they have some great examples of casting errors, mostly caused by the molten bronze cooling too quickly while being poured and not filling the mould correctly.

(2) The Bronze Age pin is a gorgeous object that would have been an impressive possession and a sign of status. It is in the box in both its “as cast” and completed form - the final object being highly polished. Handling this object will cause the bronze to dull and lessen its impact so it is worth handling it with the cotton gloves provided, as genuine archaeologists would do, to preserve its shine and impact. |
| **Links and Further Information** |
| Further information is available on the ARCH Experimental Archaeology project webpages <http://www.archhighland.org.uk/experimental-archaeology.asp>. The Bronze Age Metalworking section of the ARCH website has links to a video and a blog with further information and links.BooksThe results of the North Kessock project have been published in 2017 in Feats of Clay. Bronze Age metalworking around the Moray Firth, by Graham Clark, Trevor Cowie and Susan Kruse, available from the North Kessock and District Local History Society, and available in the Highland Library system. This includes an illustrated catalogue of known metalwork from the southern Highlands (bounded Auldearn to Glenurquhart, Dornoch Firth to Aviemore). Bronze Age metalworking is also featured in Trevor Cowie’s 1988 publication Magic Metal: Early Metalworkers in the North-East, Aberdeen.Objects on display in Highland MuseumsA number of museums have Bronze Age metalwork on display, particularly Inverness Museum and Art Gallery and Dunrobin Castle Museum. The Poolewe hoard is in Gairloch Museum, joining other single finds on display.Images onlineA number of images of Bronze Age metalwork from the Highlands is available on the internet, particularly on the SCRAN website [www.scran.ac.uk](http://www.scran.ac.uk), with free access for schools and many library users. Other images are on the ARCH website [www.archhighland.org.uk](http://www.archhighland.org.uk) in the Find of the Month archive.* Late Bronze Age hoard from near Dingwall, with a sunflower pin, axeheads and neckring.Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-000-142-177-C&scache=2qfvq1nt0j&searchdb=scran) and [ARCH](http://www.archhighland.org.uk/news.asp?newsid=37) websites
* Dail na Caraidh, near Fort William hoard of early Bronze Age axes and daggers on display at Inverness Museum and Art Gallery. Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-000-597-582-C&scache=1107w1xfo3&searchdb=scran)
* Bronze Age sword from Inverbroom. Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-000-577-395-C&scache=210al1xfoz&searchdb=scran)
* Anvil with scrap hammerhead and spearhead from Auldearn on display in Inverness Museum and Art Gallery. Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-000-597-561-C&scache=510c61xfoi&searchdb=scran)
* Stittenham Late Bronze Age axehead mould. Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-100-034-219-C&scache=210xp1xfou&searchdb=scran) and [ARCH](http://www.archhighland.org.uk/news.asp?newsid=170) website
* Knockgrainish Early Bronze Age axeheads, on display at Inverness Museum and Art Gallery. Details on [ARCH](http://www.archhighland.org.uk/news.asp?newsid=140) website
* Early Bronze Age axehead from Auldearn. Details on [ARCH](http://www.archhighland.org.uk/news.asp?newsid=57) website
* Early Bronze axehead from Culbin near Evanton, now on display in Dingwall Museum. Details on [ARCH](http://www.archhighland.org.uk/news.asp?newsid=27) website
* Decorated axehead from Nairn. Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-100-034-224-C&scache=510c61xfoi&searchdb=scran)
* Poolewe late Bronze Age hoard with axeheads, rings and cup-shaped ornament. Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-100-034-434-C&searchdb=scran)
* Heights of Brae gold hoard (on display at the NMS in Edinburgh, with replicas in Inverness Museum and Art Gallery). Details on [SCRAN](http://www.scran.ac.uk/database/record.php?usi=000-100-043-981-C&scache=2qgb61nt0p&searchdb=scran)

Other Videos[Ewart Park Bronze Age Sword](http://www.youtube.com/watch?v=qGqPnzkRZp4) (13:40)www.youtube.com/watch?v=qGqPnzkRZp4Neil Burridge makes a Bronze Age sword[Liquid fire to metal](http://www.youtube.com/watch?v=eEWIuyeNp2k) (3:13)www.youtube.com/watch?v=eEWIuyeNp2kNeil Burridge demonstrates bronze casting[Bronze Age Casting – Axe heads](http://www.youtube.com/watch?v=MI14SjbiEdM) (3:28)www.youtube.com/watch?v=MI14SjbiEdMJames Dilley, who did the ARCH flint knapping workshop, demonstrates making axeheadsWebsitesNeil Burridge’s website: [Bronze Age Craft](http://www.bronze-age-craft.com) |

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