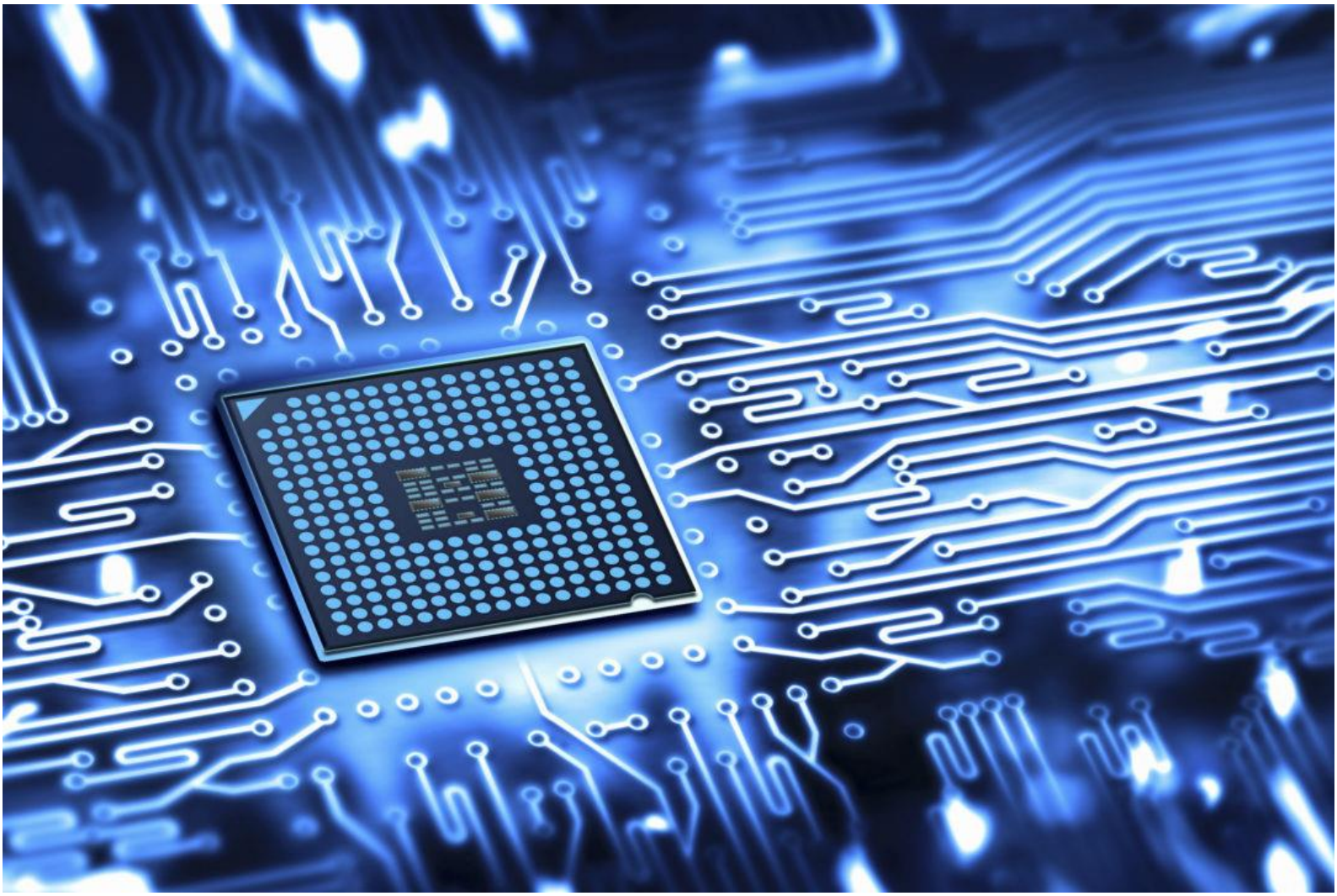
UK Electronics Skills Foundation

Extended Project Qualification Guide for Electronics



> “EPQ students had a higher probability of achieving a first (or at least an upper second) in their degree.”
>
> **Cambridge University Press & Assessment**

Foreword

The Extended Project Qualification (EPQ) is an A-level standard standalone qualification designed to extend and develop your abilities beyond the A-level syllabus and prepare you for further study in Higher Education or for your next career step.

It is highly valued by Higher Education Institutions as it demonstrates dedication to independent learning. Therefore, it is often included in offers made to applicants and it can be worth as high as 28 UCAS tariff points.

This booklet provides a guide for selecting an EPQ in the fields of Electrical and Electronic Engineering and Computer Science and successfully completing it.

About UKESF

Founded in 2010, the UKESF is the only STEM organisation in the UK solely focused on Electronics. A key aspect of the UKESF’s work is focussed on connecting Higher Education with industry. We have partnerships with 28 leading universities, right across the UK, and a Scholarship Scheme for undergraduates. More than 750 students have participated in the Scholarship Scheme, which prepares undergraduates for industry and provides a valuable skills pipeline to UK organisations. In 2022, the Scheme received external recognition and won a Princess Royal Training Award.

Contents

What is an EPQ?

The EPQ is a qualification through which students choose an area of interest in order to conduct their own research and develop the skills required for university level study. Moreover, it offers the opportunity for you to research about a topic that you are passionate about.

An EPQ should be a fun endeavour which challenges you in the right ways and should act as a portfolio piece that showcases your research and communication skills. The schematic in **Figure 1** below outlines the key stages of the EPQ.

The outcome of this project can be either a 5000-word written report or an artefact alongside a 1000-word report about the creation of this artefact.

By selecting an EPQ and completing it, you will be able to develop a wide range of study skills, such as:

- become more critical and reflective by analysing your own experiences to improve the way you learn or work.
- be a better decision maker and problem solver.
- improve your planning, research, analysis, synthesis, evaluation and presentation skills.
- have confidence when using new technologies.
- demonstrate creativity, initiative, and enterprise.

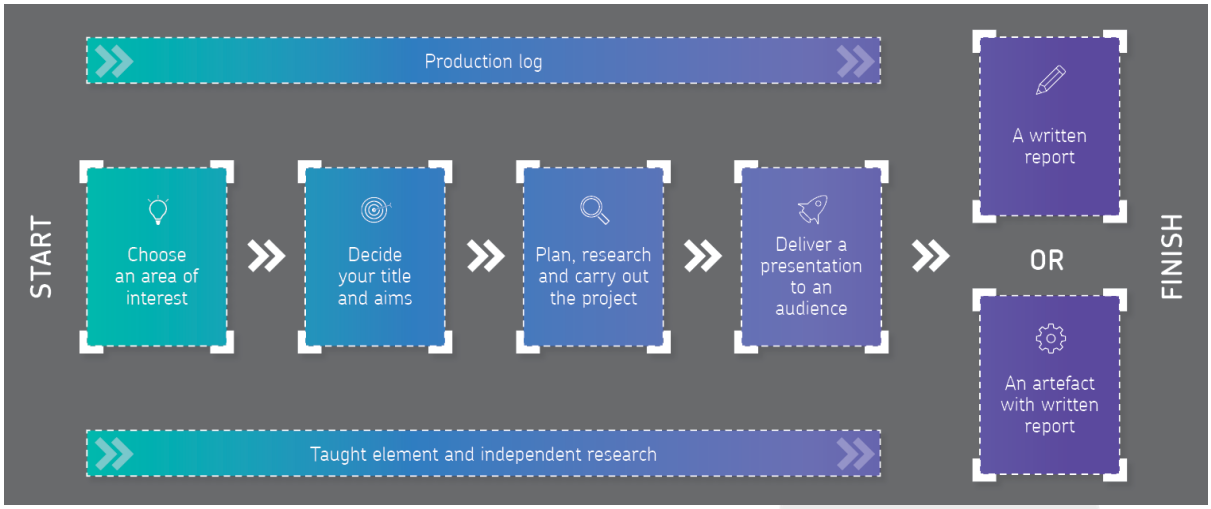


Figure 1: EPQ journey through the project[1]

[1] "Projects Student Recruitment: PowerPoint for Teacher - AQA." *Level 3 Extended Project Qualification | Planning Resources*, AQA, 22 Sept. 2021, filestore.aqa.org.uk/subjects/AQA-7993-SR-PRES.PPTX.

"We welcome the introduction of the Extended Project Qualification and would encourage you to undertake one as it will help you develop independent study and research skills and ease the transition from school/college to higher education."
University of Cambridge

"The University recognises that some A level students may also choose to offer the Extended Project. In such cases, some admissions tutors may make two alternative offers, one of which involves success in the Extended Project (for example, either AAA at A level or AAB at A level plus Extended Project)."
University of Bristol

What universities think about EPQs

The EPQ is greatly valued by Higher Education Institutions (HEI) as it demonstrates your dedication to independent learning.

Many UK universities make differed offers to students undertaking an EPQ alongside A-level qualifications, including several Russell Group universities such as the University of Leeds, the University of Sheffield, the University of Cambridge, University of Bath, the University of Southampton, amongst others.

Above are some of the comments made by university admission tutors regarding the EPQ.

In a report published by Cambridge University Press & Assessment found three clear conclusions on their research into EPQs.

- Students taking an EPQ were more likely to progress to HE (88.5% within the next 3 years) than those not taking the qualification (66.8%).
- Students taking an EPQ who did go to university were less likely to drop-out (2.3% in year 1, 4.3% by the end of year 2) than non-EPQ students.
- EPQ students were more likely to achieve a good degree classification (31% achieved a first and 87.7% at least an upper second) than non-EPQ students (24.6% and 79.6% respectively).

Why undertake an EPQ in Electronics?

Electronics have a great impact on various aspects of modern society and culture, such as communication systems, power generation and transmission, health care and cybersecurity. The main driver behind the advancement of Electronics is the semiconductor industry, which produces the basic materials and components for electronic devices and circuits. The semiconductor industry is one of the largest sectors in the global economy, with an annual revenue exceeding $580 billion in 2022.

Studying and preparing for A levels can often feel like a learning and acquiring knowledge about different subjects which may not be directly linked to each other, whereas undertaking an EPQ can give you the opportunity to get a wider perspective on how your subjects or just any interest you have fits into things in the wider world. Committing to individual learning outside of the classroom sets you up great for both university and just life itself. Furthermore, it will help you decide if this is the subject area you want to pursue in the future and help narrow down your choices.

An EPQ in Electronics will provide you with the opportunity to discover and contribute to the growth of technology in a variety of industries.

Assessment Criteria for the EPQ

As a student, you are required to meet the following four Assessment Objectives (AO). These AOs are weighted as follows:

AO1: Manage – 20%

- identify the topic
- identify project aims and objectives
- produce a project plan
- complete the work by applying organisational skills and strategies to meet the stated objectives

AO2: Use resources – 20%

- obtain and select from a variety of resources
- analyse data
- apply information relevantly
- demonstrate understanding of appropriate links

AO3: Develop and Realise – 40%

- problem-solving
- decision-making
- creative thinking
- to achieve planned outcomes

AO4: Review – 20%

- communication skills
- convey and present evidenced outcomes and conclusions
- evaluate own learning and performance

EPQ Final Outcomes

When undertaking an EPQ you initially need to decide on a topic and title which can be refined as the project progresses. This title can lead to either a written report or an artefact with a supporting report.

Written Report:
A written report is used when the topic is an investigation, exploration of a hypothesis or extended essay or academic report. The report is about 5000 words in length. The report should be written in formal academic style and be fully referenced with an accompanying bibliography. Conclusions and findings should be clearly articulated.

Artefact:
For artefact projects, the key aim will be to produce a fully functioning, fit-for purpose artefact. The report that accompanies the artefact should demonstrate a synthesis of the research and how the research has influenced every single design decision that underpins the final product. This report needs to be a minimum of 1000 word.

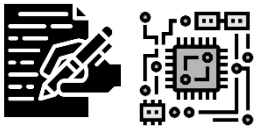
When first proposing the project title, consideration needs to be given to the success criteria so at the end you can judge how well the artifact has been created.

Planned research should form the largest part of your project and the production of the artefact should only start once this detailed and wide research is completed; all artefact projects must be research-based and have a clear purpose.

You will need to demonstrate appropriate decisions throughout the project process. For example, choosing the correct tools and materials to work with and justifying this decision. You must also ensure that the outcome is consistent with the plan you agreed with your supervisor during the mid-project review meeting.

What will you produce and submit as evidence at the completion of the EPQ:

Candidate record form, production log and assessment record
These documents are an ongoing record throughout the EPQ that are filled in by both your supervisor and you, including project proposals and final presentation record.



Final Product
Either a 5000-word written report, or your artefact with a 1000-word report.

Presentation
At the end of your EPQ you are expected to give a presentation to your supervisor (and maybe some of your peers as well)

Suggested topics in Electronics

In the following sections some topics around the broader field of Electronics are discussed which may help you decide on your EPQ title.

A. Semiconductors

Semiconductors are a type of material which have electrical conductivity between that of a conductor and an insulator.

They play a fundamental role in modern electronics and are used in a wide range of electronic devices including transistors, diodes, integrated circuits, LEDs, and much more.

They underpin our economy, national security, and modern way of life. For this reason, the UK government has recently published a National Semiconductor strategy, along with a £1 billion investment.

Possible EPQ titles:

The following are possible titles for a written report EPQ on semiconductors.

The Environmental Impact of the Semiconductor Industry

The semiconductor industry is facing an enormous challenge: Semiconductors are the basis for most of our everyday electronic devices and demand is increasing worldwide. Manufacturing is very energy and resource intensive. This creates a paradox for the industry. On the one hand, semiconductors are becoming increasingly important for achieving ambitious climate protection targets. Yet on the other hand, growing demand for these technologies means that an increased number of chips is required the production of which emits greenhouse gases.

Future of Semiconductor Performance when approaching the limits of Moore's Law

As it stands, semiconductor technology rapidly approaches the limitations of Moore's Law. Manufacturers must find new ways to improve future semiconductor performance. A possible EPQ could be around the opportunities offered using new semiconductor materials in Electronics.

How Diversity & Inclusion Can Help Combat the Semiconductor Talent Shortage

In the UK women represent about 12% of the technical roles in the semiconductor industry. But in other countries this figure is nearer 50%. Why in the UK are women, and other underrepresented groups, not taking jobs in the semiconductor industry?

B. The Internet of Things (IoT) – microprocessors and sensors

The Internet of Things (IoT) describes devices with sensors, processing ability, software and other technologies that connect and exchange information with other devices and systems.

The IoT can be incorporated on a large scale in big industries to improve productivity and efficiency, but equally on a smaller scale at your school to facilitate learning.

On a smaller scale there are lots of microprocessors and sensors that are readily available for you to create your IoT system to improve your life or those of others.

A popular device with an embedded microcontroller which is broadly used with sensors for some dedicated tasks is a device called Arduino. It is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards have the ability to read inputs, such as a light on a sensor, a finger on a button, or a Twitter message, and convert it into an output. Through this output a motor can be activated, an LED can be turned on, or some text can be published online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

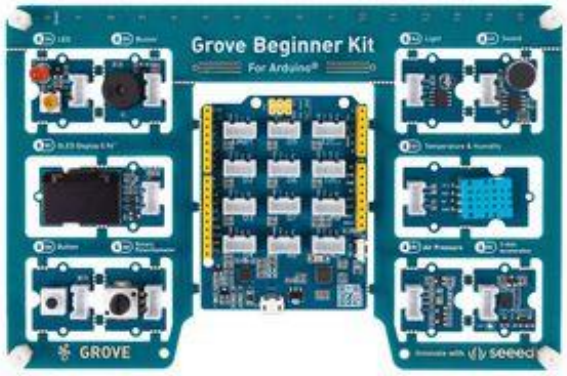
The UKESF uses a variant of the Arduino nano board called the Grove beginner kit. A picture of this kit is shown in Figure 2. This kit provides a set of electrical components to go with the Arduino nano that can be used to make several different projects.

All the modules are connected to the Arduino through the PCB stamp holes, therefore no cables are needed to connect.

You can also take the modules out and use cables to connect the modules should the project demand it. On the board there are the following sensors:

- LED & Buzzer
- OLED display
- Potentiometer & button
- Air pressure sensor & Accelerometer
- Temperature & Humidity sensor
- Light and sound sensor

For people new to Arduino the kit allows you to experiment with different electronic components before you decide on the type of project that you want to create.

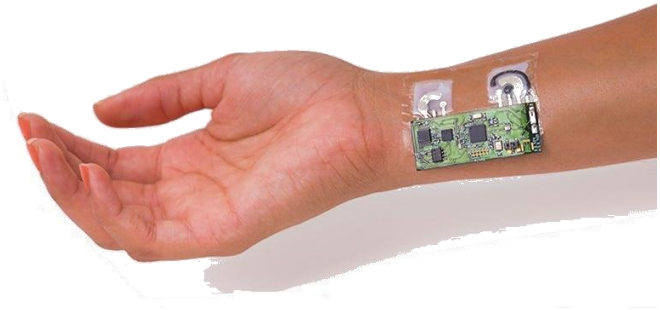


Possible EPQ titles:

Here are some potential projects that you can research and create using IoT and an Arduino board.

Healthcare – Physical and Mental Health

- A friendly companion that can be an emotional check in, fidget toy and help to reduce anxiety.
- Investigation into ways to monitor movement of a person in a room to auto-detect if they have fallen and will need assistance.
- Monitor heart rate and send data remotely to be monitored by a relative.
- A game to measure an individual's reaction time and displays the result on the OLED screen.
- Increase productivity in neurodivergent people with a physical Pomodoro tomato timer.



Transport

- An automated indicator bike helmet which will automatically turn on integrated indicator lights when the user tilts their head.
- A device that attaches on parcels to monitor if they have been tampered with.

Environment

- An automated solar composter that can automatically rotate a home composter tumbler and monitor it.
- An automated houseplant monitoring system.
- A greenhouse sensor that detects temperature and humidity and in addition produces a warning when these values exceed the high and low thresholds.

C. The Ethics of AI and its Trustworthiness

Artificial intelligence is becoming a much more widely used tool within the modern world. With the introduction of online tools such as chat GPT the general populus has become more trusting of what Artificial intelligence can provide us. With this in mind, there is still a large number of sceptics, these people are worried that AI may make some job roles obsolete or be unsafe when operating autonomous vehicles or other engineering systems. The world is now looking for ways that it can prove the trust worthiness of AI.

In addition to all this you may want to research about the data AI uses. Where is it finding the data that AI makes decisions on and is this data reliable?

AI comes with a load of interesting points both ethically and technically and so would be the perfect topic for any type of EPQ.

Possible EPQ titles:

- Gender Bias And Artificial Intelligence
- How should schools deal with ChatGPT - embrace it or ban it?
- Is AI biased, racist, and sexist?
- How will AI affect the Gaming Industry?
- What government policies are required to allow the use of autonomous vehicles publicly.

D. Renewable energy and climate change

Renewable energy is energy generated from natural sources that are replenished at a higher rate than they are consumed. Major sources of renewable energy include solar, wind, hydroelectric, tidal, geothermal and biomass energy, which is derived from burning plant or animal matter and waste.

Switching our reliance on fossil fuels to renewable energy sources that produce lower, or no greenhouse gas emissions is important in tackling the climate crisis and achieve Net-Zero emissions by 2050.

One of the United Nations (UN) Sustainability Development goals is to:

"Ensure access to affordable, reliable, sustainable and modern energy for all."
UN Sustainability Goal No. 7

Semiconductors play a key role in the development of green technologies. They are used to harness, convert, transfer and store renewable energy as electricity and subsequently move it onto the power grid with minimal loss.

Semiconductors are also incorporated in a variety of other applications that contribute to the green transition, such as:

- Energy-efficient lighting
- Smart homes and buildings
- Renewable energy storage
- Environmental monitoring

Possible EPQ titles:

For this topic, there is a variety of EPQ titles you can consider: from either one where you produce a design for a renewable energy system or to a practical monitoring system or to a more essay-based title, looking at current technologies and their potential impact. A few examples are:

- A system for monitoring water pollution in local rivers and ponds.
- An intelligent wind turbine system controlled by an Arduino. The intelligence is detecting wind direction and speed to optimise the wind turbine.
- How smart meters can contribute to tackling climate change?
- Which renewable energy technology should the UK government invest in?
- Develop a concept design for the combined energy supply and transport for a carbon-neutral powered imaginary city of 2 million inhabitants covering an area of about 100km^2.
- Develop a plan to meet UK's electrical power demand between 2025 and 2040 based on an achievable and sustainable infrastructure development. Include an assessment of future demand, a list of carbon free means of generating and supplying electrical power, benefits and constraints of each technology, and a plan for electrical power generation and supply for the UK based on.

E. Electric vehicles and the future of a battery-powered world

Few areas in the world of clean energy are as dynamic as the electric car market. Electric vehicles are the key technology to decarbonise road transport, a sector that accounts for around one-sixth of global emissions.

Electric cars have several benefits when replacing internal-combustion engine cars, including a significant reduction of local air pollution, as they do not emit exhaust pollutants such as volatile organic compounds, hydrocarbons, carbon monoxide, ozone, lead, and various oxides of nitrogen.

But what are the environmental costs of manufacturing the electric car? What happens to the batteries when their efficiency drops?

Possible EPQ titles:

- The future of Electric Vehicle Batteries
- Can the zero-emission car sales target be reached by 2035?
- Exactly how good for the environment are electric cars?
- Which battery technologies use materials that could be recycled?

Hints and tips

Topic

Choose a topic which really interests you and one you want to find out more about. Hopefully the ideas in this booklet will help you find the right one for you.

Research

This is a very important. You should try to use many sources.
Primary data sources are important. This data can be acquired in many ways, from questionnaires, interviews, online polls, forums, observation and experimentation.

Assessment Criteria

Refer to the assessment criteria to ensure your project can fulfil the EPQ requirements. Remember that you will need to complete a project log as well as give a presentation in addition to your final report and/or artefact.

Managing Time

Set yourself deadlines for each area of your project to help you keep on track – and try to stick to these as much as possible.

Help

Don't forget to ask for help when needed – your supervisor is there to support you through the project. In addition, see the section below on help from UKESF.

UKESF support for teachers and students

At the UKESF we are committed to encouraging more young people to pursue careers as Electronics Engineers. We do this through raising awareness and interest in Electronics and by supporting the development of those who choose Electronics to study.

Therefore, if you are a student, or teacher, and would like guidance about selecting and completing an EPQ, then we are here to help you.

As well as our core UKESF team, we have access to a network of hundreds of engineers and industry experts working in all different aspects of Electronics from semiconductor 'chip' design through to biomedical devices and to autonomous, self-driving, cars. We also have partnerships with 28 universities right across the whole of the UK and so can provide access to students, and make connections to academics with specialist research interests in Electronics.

In the first instance, if you have any questions, please contact the UKESF via: electronics.everywhere@ukesf.org.

As organisation we can answer any queries related to EPQs. If appropriate, we can bring you into contact with engineers, current undergraduates or a university member of staff who can help and provide more detailed advice about your chosen EPQ topic.
Finally, we can help with any wider questions you may have about the Electronics and the semiconductor industry in the UK and help you make choices about study and careers.