The Institute of Physics' Response to the Curriculum and Assessment Review

IOP Institute of Physics

Executive Summary

Physics curriculum

1) The Institute of Physics (IOP) recommends a set of design principles for building physics curricula, at all ages based on big ideas and the practices and ways of thinking of physics.

2) We recommend, in line with the Gatsby's Good Practical Science that, on average, students should experience some purposeful, hands-on practical activity at least every other science lesson, in a way that is integrated to the learning.

3) We recommend that formulae continue to be provided for exams in some format.

4) We recommend that there should be greater coherence and consistency about the teaching of climate change; and that consideration should be given to specifying content relating to climate change and how to solve it in a coordinated way across the sciences and geography.

5) We recommend that students are given plenty of opportunities to experience and develop technical, manipulative and creative skills during their mainstream schooling up to 16. We recommend that students are given more experiences of technical activities up to 16 so that they can make a genuine choice. Some of this can be achieved through meaningful and frequent experiences of practical work in the sciences.

Single route

6) The sciences are a core subject up to 16; and they are currently taught in a balanced way. The IOP recommends that they continue to be both balanced and core to 16.

7) We recommend that the sciences are timetabled, taught and graded separately for all students regardless of whether it is for two or three GCSE qualifications.

8) We recommend that all students are taught biology, chemistry and physics separately – preferably by an in-field, specialist teacher. That is, all students should benefit from the advantageous features of the current "triple science" route, which are that each of biology, chemistry and physics is:

   - specified and examined separately with its own grade;
   - timetabled separately with at least two identified lessons per week;
   - allocated a separate teacher who is generally a specialist in that science;
   - specified at a level that prepares some students to study A-level in any or all of the sciences.

   To ensure that all schools are able to provide specialist teachers in each of the sciences, they should be able to access a fully funded, comprehensive retraining courses in shortage subjects.

9) We further recommend that the amount of time allocated to the sciences allows space in the timetable for other subjects and a broad curriculum. This is likely to be between 20% and 25% of the school timetable time. The amount of content in the sciences should be chosen to fit within this time without the need to compress that content accelerate the pace of teaching.

10) Therefore, we recommend that the sciences to GCSE should be taught via a single route based on the three separate sciences. This route will be followed by the vast majority of students. We expect it to be the default route for all students unless there is a good reason that they cannot follow a common GCSE pathway. It will be taught with the features listed above and fit into between 20% and 25% of timetable time. The amount of content will be chosen accordingly, and the level of content will be unchanged.

Assessment

11) We are concerned that recent assessment schemes have focused on a narrow range of capabilities – most notably an over-reliance on short-term memorization.

12) The IOP recommends (in The fundamentals of 11 to 19 physics: a framework based on the big ideas and practices of physics) that the written curriculum in physics is defined and developed in a principled way based on the big ideas and practices of physics so that students develop capabilities that are of enduring value. Assessments should then be developed to, as best as possible, assess those capabilities. I.e. learning that is seen as being of value should drive assessment design and innovation; rather than what is taught and learned being driven by the constraints of an assessment scheme that is easy to implement.

13) We recommend investigating modes of assessment that rely, at least in part, on teachers' trusted judgement without adding excessively to their workload. Assessment of students should not be used as a replacement for trust in teachers.

14) We recommend reviving and exploring different forms of assessment and assessment items that encourage a broader range of skills and capabilities to be developed through the course.

15) We recommend that consideration is given to alternative and more varied forms of assessment – such as open book exams, observations of work and low-overhead teacher assessed grading - so that any washback into the classroom has more positive effects on teaching and learning.

16) We recommend that there needs to be a discussion about the possibility of a more diploma-style qualification at 16 to 19 with a fixed number of pre-defined combinations.

17) We recommend that consideration is given to including some forms of internal assessment in the sciences (without being overly burdensome), such as undertaking practical projects or using a form of endorsement like the implementation of the CPACs at A-level.

18) We recommend that all state-funded schools should follow the national curriculum.

END OF EXECUTIVE SUMMARY

START OF QUESTIONS AND RESPONSES

Barriers to access

10. What aspects of the current a) curriculum, b) assessment system and c) qualification pathways are working well to support and recognise educational progress for children and young people?

a. The sciences are a core subject up to 16; and the time dedicated to teaching each is broadly balanced across the three sciences. The IOP recommend that they continue to be core and balanced.

b. The level of cognitive demand of both A-level and GCSE qualifications and assessments is about right for the majority of students, even if there can be too much content; it provides stretch for high attaining students and accessibility for those with lower attainment. Although it should also be noted that the IOP has raised concerns with some exam boards regarding the difficulty of their physics exams not being suitable for the cohort being assessed.

c. In terms of progression, it is effective to teach the three sciences separately. The recent paper by Francis, Henderson, Godec et al shows that progression rates are better from the separate science route. As we note below, this improved progression can be attributed to the way that the sciences are timetabled, taught and graded as separate disciplines rather than to the amount of time allocated to the three separate GCSEs.
We recommend below that the sciences are timetabled, taught and graded separately for all students regardless of whether it is for two or three GCSE qualifications.

d. The temporary allowance of formula sheets in physics has been positive (as a relaxation of regulations after COVID). We recommend that formulae continue to be provided for exams in some format.

e. Questions in science exams are often put in context, and this is generally successful.

f. A-levels are well respected qualifications by universities and employers. It is worth noting that the International Baccalaureate is also well-regarded.

g. The systems are fairly robust. In 2023 there were 4,895 cases of misconduct out of the 867,658 students who sat A-levels that year. This robustness contributes to the international respectability of the qualification (10f above).

11. What aspects of the current a) curriculum, b) assessment system and c) qualification pathways should be targeted for improvements to better support and recognise educational progress for children and young people?

a. The high stakes nature of the terminal exams means that schools start to directly prepare students for exams from spring half term in Years 11 and 13. As a result, of a six-term course, one and a half terms are lost to preparing for or sitting exams. I.e. only 75% of available time is allocated to teaching and learning new ideas (see below).

b. Success in existing qualifications relies too much on short-term memorisation.

c. The reporting of GCSE exam grades has, for some time, not used the full range of grades. The notion of a "pass" (previously at grade C and now at grade 4/5) means that any grade below this grade is considered as being in the same bucket: "fail". The original intention of the GCSE grading system was that all grades would provide information and carry value. That intention has not been realised. We recommend that all grades at GCSE are seen as having value and all grades are used as part of assessment.

d. To an extent, the effect above has extended to A-level. Grades D and E at A-level are not regarded as highly as they were 25 years ago when they were still offered as entry tariffs to university degrees (see below).

e. There is inherent unreliability of exam grades. As Sherwood points out, up to a quarter of exam grades are wrong. If papers are marked fairly by two different examiners, the grades would be different in a quarter of papers, although this varies across subjects. This is one illustration that assessment based solely on terminal written exams is always going to serve some students badly.

f. The experience of lockdown demonstrated that it is possible to use, at least in part, teachers' judgements of students' attainment. However, that same experience showed that the systems that were required were overly-burdensome on teachers – mainly because of a lack of trust in their judgement. We recommend investigating modes of assessment that rely, at least in part, on teachers' trusted judgement without adding excessively to their workload, as seen in Canada. Assessment of students should not be used as a replacement for trust in teachers.

g. The assessment of practical work in the sciences has had some undesirable effects on the way that the sciences are taught. This has been compounded by the experience of lockdown, when students were unable to access equipment to carry out practical work. The Royal Society's SET Tracker report found that "The percentage of GCSE students doing hands–on practical work at least fortnightly dropped from 44% in 2016 to 37% in 2019 and 26% in 2023". Although the latter part of this drop is clearly related to the pandemic, the initial decline (and subsequent continued decline) can also be attributed to the assessment requirements. Students are able to answer the questions relating to physics practical activities in the exam by knowing about either 6 (Combined Science) or 8 (Separate Physics) core practical activities. As a result, it is clear that schools are not giving students experiences of practical activities that are not in the list of core practicals. See the response to question 26 for the IOP's proposed solution to this problem.

h. The SET Tracker showed that 42% of young people are interested in learning about the climate. However, teaching and learning about climate change is currently ad hoc, piecemeal, repetitive and focuses on the causes and problems rather than on the solutions – contributing to 'climate anxiety.' We recommend that there should be greater coherence and consistency about the teaching of climate change; and that consideration should be given to specifying content relating to climate change and how to solve it in a coordinated way across the sciences.

i. Some state-funded schools are exempt from following the national curriculum. This downgrades the value of the national curriculum and implies that some schools are more able to make their own decisions than others. We commend that all state-funded schools should now follow the national curriculum.

12. In the current curriculum, assessment system and qualification pathways, are there any barriers to improving attainment, progress, access or participation (class ceilings) for learners experiencing socioeconomic disadvantage?

a. Students from lower socio-economic groups are less likely to progress to A-level physics than those in higher SES groups. The IOP's own analysis of the National Pupil Database shows that, in 2017, those in the bottom SES quintile were 3 times less likely to take A-level physics than those in the top quintile. An earlier IFS study found this ratio to be higher at 1:8. Also, those in the lowest quintile who did take A-level physics were then three times less likely to achieve an A grade.

   70% of A-level physics students come from 30% of schools as seen in unpublished research undertaken by the IOP using data from the NPD. The schools with highest take-up are more likely to be in areas of lower deprivation.

b. This disparity arises in part because schools in more deprived areas are less likely to have specialist physics teachers and are more likely to allocate out-of-field teachers to teach the physics topics in the Combined Science course.

c. This disparity is exacerbated as a form of self-fulfilling prophecy in economically deprived areas. In the 2023 Teacher Survey many teachers in deprived areas cited this as a reason for making them want to leave the profession, which in turn only furthers the problem in socioeconomically deprived areas.

d. Combined Science is often taught in a way that masks the deployment of out-of-field teachers to teach, for example, the physics topics. It is timetabled as "science" and therefore is registered as having a specialist teacher if that teacher is a specialist in any one of the sciences (rather than a specialist in physics). So, even though the physics module might be the same as a physics module in separate physics GCSE, the fact that it is being taught as part of a "science" course means that the teacher is registered as specialist, even if their specialism is biology. Therefore, we recommend that all lessons that cover physics topics are timetabled and recorded as physics (rather than science); and every effort is made to allocate a physics specialist teacher to those lessons. If schools do not have sufficient specialist physics teachers, they can generate new physics teachers by giving them time to take part in an effective, extended retraining course such as the SKPT course.

e. The IOP's research into timetabling found that, in 2018, 48% of state schools allocated only two teachers to teach Combined Science. In such cases, as well as meaning that one of the sciences is being shared between two, probably out-of-field, teachers, it is likely that students have little sense of the distinction between the sciences. For triple science this figure was better, with only 19% of state schools allocating only two teachers, as opposed to the preferred three.

f. In the same research, 100% of the private schools surveyed were able to assign three teachers to the three separate sciences, and 98% assigned three teachers to combined science. This highlights a significant difference in the experiences of the most and least advantaged students in their science education; and this difference contributes to the choices these students make at A-level and likely relates to the point raised in 12.a.

g. In 2024, according to IOP data analysis, 800 schools had no students taking the separate sciences ("triple science"). 36% of students in these schools were socially disadvantaged. By contrast, 300 schools had more than 60% of their students taking the separate sciences. Only 10% of students in those schools were disadvantaged.

h. The data above shows that students in schools that are in more deprived areas are more likely to take Combined Science than the three separate sciences. This means that they are more likely to experience the detrimental effects of the physics topics being taught by out-of-field teachers, being shared between more than one teacher, and not being identified as physics. That is, they get a diminished experience of physics compared with their peers in schools in more advantaged areas who are taught physics (and the other sciences) as separate subjects (see answer to question 29).

i. In the current system, GCSE results act as a gate that determines whether students will follow an academic or technical course from the age of 16. Those who achieve a certain number of high grades at GCSE are permitted to take A-levels, students who do not perform to the required entry standard are guided towards other, often technical, qualifications. This has resulted in technical routes being used for, and associated with, students with lower academic performance at 16. Given the performance gap associated with disadvantage the chances of a student from a lower SES family achieving the necessary grades to proceed to A-levels is lower than the same chances for their more comfortably off peers.

j. As well as greatly diminishing the choices available to all students, particularly those from lower SES families, this gatekeeping contributes to a continuing lack of parity between academic and technical routes from 16. Continuing with a narrow form of assessment at 16 with choices being limited, rather than expanded, by performance in those assessments will maintain the sense that technical routes are the destination for students with lower prior attainment.

13. In the current curriculum, assessment system and qualification pathways, are there any barriers to improving attainment, progress, access or participation which may disproportionately impact pupils based on other protected characteristics (e.g. gender, ethnicity)?

a. The IOP's Closing Doors and Opening Doors reports showed that young people's decisions for post-16 study are greatly affected by gender stereotyping and gendered expectations of choices. Girls' subject choices are particularly affected by the biases of their environment (and the same may be true for some other underserved groups, albeit studies have not yet been carried out to validate this); and, given existing biases about who does physics, this has an impact on the numbers choosing the discipline (see answer to 15). The problem of stereotyping is a whole school issue and needs to be tackled by a whole school policy on equity (see 15a for solutions).

15. In the current curriculum, assessment system and qualification pathways, are there any enablers that support attainment, progress, access or participation for the groups listed above? [e.g. socioeconomically disadvantaged young people, pupils with SEND, pupils who are otherwise vulnerable, and young people with protected characteristics]

a. In the Drayson trial of 2016, the IOP found that the number of girls taking A-level physics across 6 pilot schools increased by a factor of 3. The trial had taken a whole school approach to equity.

b. We recommend, as good practice, that all schools should develop and implement a whole school equity plan with explicit recommendations that teachers challenge stereotypical views about subjects and who can study them (including physics) and ensure that all students feel that they can take part in all subjects.

c. To encourage schools to develop and implement a whole school equity plan, the IOP initiated the Gender Action project which provides a quality mark to schools that take action on actively challenging all gender stereotyping and expectations.

d. As we discuss in detail in our answer to question 29, students from lower socio-economic groups are more likely to succeed, enjoy and progress in the sciences if they are provided with a route through the sciences at GCSE with the following features: the three sciences are specified, assessed and graded separately, and they are taught separately by a subject specialist teacher. That is, these students should be given the advantages of the existing "triple science" route although, as we discuss, this route is unlikely to occupy the time required for three separate GCSEs.

e. As we discuss in our responses to questions 26 and 33, the IOP recommends broadening the types and modes of assessment from the very narrow focus of existing exams and assessments. Existing assessments are heavily reliant on short-term recall of facts as part of a written assessment under exam condition. As well as providing an incomplete picture of the breadth of a young person's capabilities, this approach does not provide due recognition to students who have capabilities or skills in other areas that cannot be assessed by such restrictive assessment methods.

f. As we discuss in paragraphs to 26-h and 12-l, students should experience, learn and be assessed on technical and manipulative skills before the age of 16 so that they can make a genuine choice of route beyond that age. The existing system of assessing a narrow range of largely academic capabilities at 16 and using them as a filter that prevents some students from following academic courses from 16 has the effect of steering students with educational advantages onto A-levels and those with fewer educational advantages onto technical and vocational routes.

Maths and English

19. To what extent do the current maths and English qualifications at a) pre-16 and b) 16-19 support pupils and learners to gain, and adequately demonstrate that they have achieved, the skills and knowledge they need? Are there any changes you would suggest that would support these outcomes?

a. Although there are Core Maths modules for 16- to 19-year-olds, these currently do not provide specific support for students taking physics or other numerate A-levels. In England, about 144,000 students achieve a grade 7 in maths GCSE and about 88,000 take A-level. So, there are approximately 50,000 students who could have taken maths A-level but chose not to do so. Many of those students will be taking numerate subjects at A-level but not maths.

b. Maths A-level is a helpful support for those taking physics and the other sciences at A-level. Currently about 5,500 students take physics A-level but not maths A-level. Consequently, physics A-level cannot draw on ideas from maths that are more advanced than GCSE. This limitation restricts A-level physics to providing explanations not containing, amongst other things, calculus, as this is not taught at GCSE level.

c. Providing those students who currently take physics (and other numerate subjects at A-level) but do not continue with maths, with a well-developed maths course that supports their studies would allow physics teachers to provide explanations based on maths ideas that are more advanced than GCSE. It is our opinion that these explanations are often easier to follow than the non-mathematical versions. Specifically in physics, it would be very helpful if such a course included ideas about calculus.

d. A further benefit of a maths-for-sciences course is that it would also provide students who want to progress to undergraduate degrees with a more authentic view of physics and engineering, as mathematical subjects, when they are making their degree choices.

Other subjects

22. Are there particular curriculum or qualifications subjects where: a) there is too much content; not enough content; or content is missing; b) the content is out-of-date; c) the content is unhelpfully sequenced (for example to support good curriculum design or pedagogy); d) there is a need for greater flexibility (for example to provide the space for teachers to develop and adapt content)? Please provide detail on specific key stages where appropriate. *This includes both qualifications where the government sets content nationally, and anywhere the content is currently set by awarding organisations.*

a. The existing GCSE qualifications in the sciences, for both the separate sciences and Combined Science, have too much content.

b. This excessive content is felt particularly in the three separate sciences ("triple science") where many schools teach them on a compressed timetable. However, even were they to be given the full amount of time, there is still too much curriculum content.

c. This overloading reduces the time available for: exploring ideas deeply, providing and discussing local contexts, and for carrying out meaningful practical work.

d. The point above has resulted in a growing attitude of "if it's not in the exam, we won't teach it or learn it," or as was said by an Ofsted chief inspector that this is a 'pub-quiz approach to education.' Consequently, most teaching is focused on what is going to be in the final written exam. This diminishes the quality of learning because not everything that is worth learning is being assessed under the current assessment system.

e. In 11b, the IOP mentioned that many exams rely largely on short term memorisation. This is true for physics papers. As such, it means that students are given an unrepresentative experience of physics. In some recent focus groups with A-level students who had chosen maths A-level but not physics, they reported that one of the reasons that they had not chosen physics was that there was so much to memorise. This is an unrepresentative view of physics.

f. It is the IOP's position that greater consideration must be given to what knowledge and capability endures beyond the end of the period of study; and therefore, greater consideration must be given to developing deep and lasting capability and knowledge rather than extensive, short-term recall. We would like to see a curriculum, in physics, that aims to develop enduring, powerful knowledge and capability through a relatively small set of big ideas that include the practices and ways of thinking of physics.

g. In our document The fundamentals of 11 to 19 physics: a framework based on the big ideas and practices of physics, we recommend a set of design principles for building physics curricula, at all ages.
    - One of the most important of these design principles is that the core ideas of physics can be expressed as a relatively small set of 'big ideas.' This is to improve coherence

and provide a sense of purpose to the detailed content; and to ensure that the curriculum does not become overloaded.

- These design principles also recommend being explicit about the practices and ways of thinking in physics, so that they can be deliberately developed as part of a teaching scheme. As Counsell points out, it is important that students gain disciplinary and epistemic knowledge as well as the substantive knowledge of each discipline. Physics – and other disciplines – are often just as much about what students can do as what they know. Therefore, we recommend specifying, teaching and assessing the practices and ways of thinking as well as the substantive knowledge. It is these practices and ways of thinking that makes each discipline distinct and gives us confidence in its ideas and explanations.
- A curriculum should also provide opportunities and encouragement for contextualisation of physics in occupations, in the local area and for solving global problems. This requires some exemplification; however, central prescriptions of context don't work well; contexts are more effective if they are chosen by teachers who know their students and the locality; as such, they need space within the curriculum to be able to include those contexts.

h. The question implies that specifications provide a sequence for teaching. Although, worryingly, there may be schools and teachers that use the specification as a teaching sequence, it should not be regarded as such.

23. Are there particular changes that could be made to ensure the curriculum (including qualification content) is more diverse and representative of society?

a. Curriculum content, examples and perspectives in physics should recognise that the development of the discipline relied on ideas and thinking from many people and varied groups globally. Children should be offered a chance to learn about historic contributions to the sciences from around the world, as well as the cutting-edge contemporary research produced by diverse teams of scientists.

b. Ideas should be framed in the context of the times in which discoveries were made and accredited within western science. They can explain how many of those discoveries drew on earlier work in other parts of the world and how, during the period of growth of western science, different groups, cultures and nations were more or less able to participate in research, resource scientific activity, or claim credit and ownership for ideas.

c. The Aspires programme has shown that an effective way to help young people – especially those in under-represented groups identify with physics and therefore be more likely to choose a physics-related course beyond 16, is to provide contexts that are familiar and local to them. This can be achieved by teachers "building on their knowledge of students' interests, aspirations, local communities and past experiences" and "using examples and settings that are familiar and local to students as 'hooks' into the science content."
For the purposes of curriculum design, this means providing some example contexts and keeping space in the curriculum for teachers to provide their own contexts.

d. The IOP has developed further Top Tips for Inclusive Science Teaching as part of its Limit Less campaign. Some of these apply to curriculum design:

- Look for, examine and challenge stereotypes, biases and assumptions within any science or physics curriculum

- Model inclusive language in curriculum documents

- Build scientific vocabulary

- Provide space to:
    - Teach about a range of jobs and careers that use science and science skills.
    - Encourage student discussions.
    - Give students opportunities to make links between their learning and their lives, interests and local area.
    - Think about and get to grips with the maths.

Broad curriculum

26. In which ways do the current secondary curriculum and qualification pathways support pupils to have the skills and knowledge they need for future study, life and work, and what could we change to better support this?

a. There is a very narrow range of assessment types within GCSE qualifications. Nearly all assessment takes place through a timed, terminal examination that has a large emphasis on recall.

b. Therefore, under the existing system, exams at 16 assess a very narrow range of capabilities – with a focus on short-term memorisation. Working towards this assessment method washes back into the ways that the subjects are taught, resulting in most learning up to GCSE being focused on memorisation of detailed facts.

c. There is very little emphasis on developing different forms of disciplinary or epistemic knowledge across different subjects. In physics (and the sciences), some aspects of procedural knowledge are specified and assessed (albeit with some concerns – see d below); however, the practices and ways of thinking of physics are not systematically described or assessed.

d. The way in which practical work is assessed at GCSE has resulted in a decrease in the amount of practical work being carried out. Whilst it is advantageous (for completing exam questions) for students to have had hands on experience of carrying out the set practicals, it is by no means essential. In the current system, there is also no direct assessment of their procedural knowledge or their ability to use or manipulate apparatus. As a result, students are getting less direct experience of practical work - despite many students wanting to do more practicals in their science classes. This also links to the paragraph 26.h.

e. The IOP recommends that, in line with the Gatsby's Good Practical Science that, on average, students should experience some purposeful, hands-on practical activity at least every other science lesson, in a way that is integrated into learning.

f. Additionally, there is little opportunity for students to carry out extended investigations in the sciences. In the last curriculum review, long-form investigations were removed from GCSE courses on the basis that they were an unreliable form of assessment. Given that they were removed from GCSE courses, they were also removed from A-level. That removal has diminished both the quality and the experience of A-level courses in physics and the sciences.

g. We recommend reviving and exploring different forms of assessment that encourage a broader range of skills and capabilities to be developed through the course (for example, but not limited to, laboratory work, advanced problem solving, teamwork, and demonstrating the ways of thinking within a discipline).

h. Most existing GCSE courses offer very few opportunities for students to experience or develop their technical and manipulative skills. It is therefore hard for them to make informed decisions about where their capabilities lie, and which route they would prefer beyond 16. As mentioned in paragraph 12-i, as things stand, it is not so much that students make a choice on preference but rather that they are not taken onto an A-level course, so they default to a technical route. This is neither fair on the students nor helpful for giving equal status to both routes. We recommend that students are given plenty of opportunities to experience and develop technical, manipulative and creative skills during their mainstream schooling up to 16. Some, but not all, of those experiences can be achieved through ensuring that there is sufficient hands-on, meaningful practical work in the sciences up to 16.

27. In which ways do the current qualification pathways and content at 16-19 support pupils to have the skills and knowledge they need for future study, life and work, and what could we change to better support this?

a. See 10.a – 10.h.

b. Young people's experience of learning a subject, and the likelihood of them choosing a route based on that subject from 16, depends hugely on the quality of their teacher. A high quality, in-field teacher is able to bring their subject to life, include and model aspects of thinking like a disciplinarian in that subject, and is likely to be enthusiastic about the subject and the opportunities it offers. However, too many 14- to 16-year-olds do not get a specialist teacher in physics so, they do not experience those advantages.

c. They are more likely to get an in-field teacher in each of the sciences if they study the three separate sciences to GCSE ("triple science"). We recommend that, whether or not they take the three separate GCSEs in the sciences, all students are taught biology, chemistry and physics separately – preferably by an in-field, specialist teacher. In that way, all students are likely to experience the benefits of learning physics (and the other sciences) in a way that develops their disciplinary and broader knowledge with the subject.

28. To what extent does the current primary curriculum support pupils to study a broad and balanced curriculum? Should anything change to better support this?

a. The IOP are concerned that the amount of time allocated to the sciences has become squeezed since the removal of statutory tests. We are not suggesting that the test should be reinstated; however, we recommend that there is statutory guidance on how much time is allocated to teaching the sciences at key stages 1 and 2.

b. As with the secondary curriculum, we are concerned that the primary curriculum in the sciences is overloaded with detailed content; and that some of this content is too advanced for some primary school children. There is no specific need for students to be able to discuss ideas of friction before they reach secondary school. Indeed, there is a risk that by including this in the curriculum, they learn that physics is difficult and fussy; and they may even pick up misconceptions from their teachers who, whilst being great primary teachers, are highly unlikely to have a scientific background. There is no need to focus on some aspects of detailed content knowledge, which will be covered in secondary school anyway.

c. We recommend that the primary science curriculum is rethought so as to provide all students with experiences of phenomena and a grounding in observing and discussing those phenomena and looking for patterns within them. Such an approach will be more equitable (ensuring that all students have had certain experiences) and more likely to help them to identify with the sciences.

d. We recommend rethinking how physics is taught at primary. There should be an emphasis on experiencing phenomena (possibly by making things) and describing behaviours without having to provide explanations based on abstract ideas.

e. In 2023, we published a report that was developed by an advisory group of primary science experts; and, in 2024, we accepted the recommendations within that report and published the combined report in full: Developing a Primary Science Curriculum. Our top line recommendations are that the primary science curriculum should:

   - have a strong emphasis on purpose, considering not just what is taught and learned, but why and how, so that children develop a coherent and cognitively appropriate understanding of how the world works and their own agency within it.
   - help children identify with the sciences by providing opportunities for teachers to choose contexts that are relevant to their pupils.
   - help all children to feel included in the sciences through the experiences that they have, and the perspectives put on science narratives and by encouraging teachers to use contexts that are familiar to primary age children.
   - ensure the curriculum plans for progression to avoid content being taught before it is appropriate for the age/development stage of the child.
   - encourage children to think scientifically, to discuss and explain their thinking and, through practical experience, gain a sense of the nature and practices of the sciences.

- contain local context and relevance to the students

29. To what extent do the current secondary curriculum and, qualifications pathways support pupils to study a broad and balanced curriculum? Should anything change to better support this?

a. The IOP strongly recommends that all students have a route through GCSEs in the sciences in which biology, chemistry and physics are taught, assessed and graded separately. That is, all students should benefit from the advantageous features of the current "triple science" route whilst not overwhelming and narrowing the curriculum by occupying the time of three full GCSEs, as it currently does.

b. Therefore, we recommend that there is a single route through the sciences at GCSE and that all students taking GCSEs follow this route. It will have the following features; each of biology, chemistry and physics should be:

   - specified and examined separately with its own grade;
   - timetabled separately with at least two identified lessons;
   - allocated a separate teacher who is generally a specialist in that science;
   - prepares students to study A-level in any or all of the sciences.

c. The advantages of this approach, are:

   - It will prevent the separate sciences being taught at an accelerated rate
   - It will prevent students being selected for an "elite route" route based on prior attainment and class setting.
   - It will reduce the impression that the sciences are the preserve of high attainers
   - It will enable *all* students to study the three sciences separately and increase their access to specialist teachers.
   - It will prevent high performance in one of the sciences being averaged down in a combined grade
   - It will provide students with specific information on where their strengths lie
   - It will improve school accountability and drive the need to recruit and deploy specialist teachers to teach each of the sciences

   We explore these advantages in the paragraphs that follow.

d. We note that GCSEs are not appropriate for all learners.

e. The existing GCSE offerings in the sciences are either Combined Science (also known as "double science") and the three separate sciences – biology, chemistry and physics (often referred to as "triple science"). The former results in 2 adjacent GCSE grades based on the cumulative performance across the three sciences (e.g. 7/8, 8/8, 8/9 etc). The latter results in 3 separate GCSE grades – reflecting the performance in each of the sciences.

f. The existing regulations state that Combined Science is taught in the time of two GCSEs – i.e. 240 to 280 guided learning hours (GLH). And that the total time allocated to the three separate sciences is between 360 and 420 guided learning hours (i.e. the time for three separate GCSEs).

g. The concerns about teaching for 3 separate sciences at GCSE start with the requirement to allocate to them the time of three full GCSEs. If they are allocated their required guided learning hours, they will do so at the expense of another subject. I.e. doing the three sciences in its allocated time will narrow a young person's curriculum.

   To overcome this narrowing, many schools offer the "triple science" route on a compressed timetable – allocating the time of 2 GCSE subjects (240 guided learning hours). As a result, each of the sciences has to be taught at a higher pace than is expected for a full GCSE. This acceleration has two detrimental consequences:

   - There is not sufficient time for these students to explore ideas deeply, carry out meaningful practical work or experience a faithful representation of the subjects. Their experience is that there is a lot to learn in a short amount of time and this is off-putting.

   - Most schools select the students who are allowed onto the "triple science" course based on prior attainment or by setting. The Science Timetable Models Research found that nearly two thirds of schools that offered "triple science" restricted access to that pathway based on setting and/or prior attainment. Under this approach, there is not a genuine choice for students to take the three separate sciences; and a message is sent to all students that they need to be a high attainer in order to take science. As well as being misleading, this message is damaging to the reputation and uptake of the sciences beyond 16.

h. Although the IOP has serious concerns about the 'triple science' route and the fact that it exists alongside the double science route (see above), it is the case that students on this route are more likely to progress to A-levels in one or more of the sciences. This can be attributed partly to their prior attainment and interest in the sciences and partly to the more advantageous (as compared with Combined Science) features of the way that the three separate sciences are specified, timetabled, taught and examined. In general, the three separate sciences are:

   - Specified and examined separately with their own grade.
   - Timetabled separately with at least two identified lessons in each of biology, chemistry and physics.
   - Allocated a separate teacher who is generally a specialist in that subject.

i. As things stand, students who take the Combined Science route do not benefit from the advantageous features above:

   - They are more likely to have an out of field teacher. With 80% of science teachers teaching out-of-field in schools that only offer combined science, compared to only 29% at schools offering only triple science. We found that 69% of schools offering

Combined Science recruited "science teachers" rather than separate biology, chemistry and physics teachers.
- They are likely to not have separately timetabled lessons for biology, chemistry and physics. In the Science Timetable Models Research we found that 46% of schools teach Combined Science as "science".
- They get a combined grade which, by definition, will be equal to or lower than their highest grade; i.e. they might have achieved 8, 7, 6 in the three sciences but will be awarded a 7,7 – thereby missing out on their highest grade and, potentially, choosing other subjects in which they achieved 8s and 9s for A-level.
- Often students will have two teachers across the three sciences; we found this to be the case in 31% of state schools for combined science classes. This results in the need for one of the sciences to be taught by an out-of-field teacher, that is teaching two of the three sciences for their cohort.
- They are more likely to be allocated an out-of-field teacher: a biology teacher teaching physics within Combined Science is counted as a specialist, because they are a science teacher teaching a science. However, that same biology teacher teaching the same physics module as part of a physics GCSE would be registered as teaching out of field. In our research physics was the most likely of the three sciences to be taught by an out-of-field teacher.
- The combined grade means that schools and teachers are not accountable for performance in each of the sciences separately. Specifically, it reduces the motivation to recruit and deploy specialist teachers for each of the sciences allowing schools to recruit out-of-field teachers to teach shortage subjects (usually physics) because, as long as they are a teacher of one of the sciences, they count as a "specialist" to teach Combined Science.

j. Therefore, we recommend that all students taking GCSEs follow the same route through the sciences in which biology, chemistry and physics are specified, graded and taught separately giving all students the advantages of the existing "triple science" route.

k. However, as has already been noted, we cannot expect all students to follow a route that occupies the time of three GCSEs (360 to 420 guided learning hours). A more reasonable allocation would be 285 to 330 guided learning hours. In this way, in most timetable models, each of the sciences could have at least two lessons per week and leave space for the other core subjects and at least four options.

l. The content in this route would take students to the same level of scientific capability and skills as the existing Combined Science and separate science GCSEs. The amount of content would be tailored to realistically fit the time available and allow for deep exploration of the ideas (including meaningful and frequent practical work). This is likely to be less than the existing separate science GCSEs – which are, as discussed, already overloaded. Whilst the breadth of content within each science is likely to be less than the breadth within an existing separate science GCSE, that will be made up for by the fact that students will gain breadth in their overall curriculum – i.e. they will take an additional subject.

m. If this route is put in place, it will, in effect, be "triple science" taught in 20% to 25% of curriculum time. It will have the same features as the existing triple science offer except that the amount of content will be reduced to fit the available time. There would be no need to offer the three separate GCSE qualifications in the sciences. I.e. this new route would be the route that the vast majority of students would follow.

30. To what extent do the current qualifications pathways at 16-19 support learners to study a broad curriculum which gives them the right knowledge and skills to progress? Should anything change to better support this?

a. Currently, within the A-level system, students specialise much earlier than they do in most high-performing jurisdictions, such as France and Germany. Whilst this arrangement means that English students start their degrees with a greater breadth of specialised knowledge, the outcomes at the post-graduate level are at a similar level to international comparisons. This means that early specialisation does not seem to offer any apparent benefit to educational outcomes.

b. There are likely costs to specialising too early. By forcing 16-year-olds to make major decisions on their future study, we create a high-stakes environment that, through mistaken choices at 16, contributes to increasing drop-out rates at both A-level and in undergraduate degrees. Therefore, there is strong case to maintain breadth for longer.

c. AS levels are now stand-alone qualifications, and they can no longer count as a module towards an A-level. The total number of entries to AS levels in England have plummeted (by a factor of more than 20) from 1.3 million in 2014 to 57,000 in 2024. For context, the total number of A-level entries has increased slightly in that period from 782,000 to 816,000. The pattern of AS uptake can be explained by the following: previously, students would generally start the sixth form with four subjects and take AS exams at the end of year 12. They would then drop one of their subjects and take the other three on to A-level. Now, students start their sixth form with three subjects that they take through to A-level whilst a relatively small proportion of students take an AS in addition to their A-levels.

d. Paragraph c shows that, although AS levels were originally intended to add breadth, they were never very successful at doing so – because they were used as a module towards an A-level; and, given how few are taken now, they certainly do not provide breadth to many students in the current system.

e. As well as providing more breadth, we would like to see more coherence between subject combinations and recommend that there needs to be a discussion about the possibility of a more diploma-style qualification at 16 to 19 with a fixed range of pre-defined combinations. For example, there might be a physical science route in which all students study maths, physics, chemistry and computing as major subjects and, in addition, three further (minor) subjects to provide some breadth.

f. The advantages of such a structure are:

- Coherence that would arise through links between subject areas; the physics and maths components can build on and relate to each other. And it allows physics (and other subjects) to draw on ideas from maths that are above GCSE level. Additionally, and in a similar way, aspects of other pairs of subjects such as chemistry and computing can build on each other thereby making the whole (of the learning) more than the sum of the parts.

- Efficiency and avoiding repetition as a result of any given content being in just one place. For example, mechanics currently appears in both maths and physics; and ideas relating to the kinetic theory of matter appear in physics and chemistry.
- Interdisciplinarity to show the links between different disciplines and develop the ability to apply knowledge outside the siloes of school subjects.

g. To illustrate the advantages above, there might be a single module on mechanics in either maths or physics or co-taught across the two. It would bring together ideas from physics, mathematics and computing in just one module. This would allow teachers and students to explore ideas within a given subject to a much greater depth because they have more time, and they can draw on knowledge that has been covered in other subjects because they do not have to worry that some students in the class have not chosen that subject.

h. There will be similar examples in other subjects such as a historical analysis of a religious event within a geopolitical context.

31. To what extent do the current curriculum (at primary and secondary) and qualifications pathways (at secondary and 16-19) ensure that pupils and learners are able to develop creative skills and have access to creative subjects?

a. JCQ data show that, in 2000, when Design and Technology was a core subject in the National Curriculum, 424,000 students took it at GCSE. This declined to about 270,000 students in 2010 and has dropped to 79,000 in 2024. The decline has not been balanced by an increased uptake in an equivalent technical or vocational qualification. The Curriculum Subjects Trends Over Time briefing paper confirms that the amount of time spent teaching D&T has dropped from just over 4% to just under 2%.

b. The drop in numbers and time are due to a number of factors – possibly including the introduction of the EBACC, a move towards emphasising academic subjects and a number of changes to the content of the curriculum. The Design and Technology Association have discussed the possible causes.

c. Furthermore, as discussed above, there are few opportunities within the core and EBACC subjects for students to create or make things with their hands.

d. As a result, the majority of students get few opportunities to develop their technical and manipulative skills; and, as discussed in 26-h above, they may not discover whether they have a specific technical or creative aptitude.

Technical/applied routes

33. To what extent and how do pupils benefit from being able to take vocational or applied qualifications in secondary schools alongside more academically focused GCSEs?

a. As discussed above in 26.b, under the existing system, exams at 16 assess a very narrow range of capabilities and act as a filter for choices of further study. Those who succeed in those exams are allowed on to academic courses – predominantly A-levels - whilst those who do not perform to the required entry standard (which is chosen by and varies across schools) are guided towards other, often vocational or applied qualifications. In other words, following a technical or vocational qualification pathway is based more on low attainment in the available academic assessment at 16 than it is on genuine, informed choice. This is not an inclusive approach to all learners, and does in fact disadvantage some young people as they do not have a free choice.

b. Continuing with a narrow form of assessment at 16 with choices being limited, rather than expanded, by performance in those assessments, will maintain the sense that technical routes are the destination for students with lower prior attainment. This is likely to drive a divide between academic, technical and vocational pathways, rather than seeking genuine parity between them.

c. We recommend that all students are given more experiences of technical activities up to 16 so that they are empowered to make more informed choices about the post-16 options available to them. Some of these experiences could be met by more emphasis on practical work in the sciences, and as noted earlier, D&T has an important role to play in enabling genuine choice but has suffered from a decline in recent years.

Assessment system GCSE

39. Is the volume of assessment required for GCSEs right for the purposes set out above? Are there any changes that could be made without having a negative impact on either pupils' learning or the wider education system?

a. There is a heavy burden of assessment at 16.

b. The existing purposes for assessment are given as "they assess learning against a defined curriculum, support progression and provide data to hold schools and colleges to account for their performance." The IOP believes that these purposes are sometimes in tension with each other, are putting too many requirements on assessment, and making those assessments too high stakes.

c. This high-stakes nature results in schools emphasising exam preparation over high quality learning. Decisions are made based on the need to achieve cross-board success in exams (for the school) rather than to maximise the quality or outcomes of learning for individual pupils. Whilst it is important that schools are accountable for their outcomes, as well as the quality of their teaching and learning, binding a single measure (exam grade) to both a student and the school has resulted in undesirable effects. These include:

    - The loss of the teaching time towards the end of year 11 to exams and direct preparation for exams. Up to a quarter of a two-year course is given over to exams and exam preparation.

- The washback of assessment and assessment styles into teaching (see answer to question 40 below).

d. The IOP recommends that consideration is given to how the high-stakes nature of GCSE assessments can be lowered thereby reducing the time lost to direct preparation for exams.

e. Assessment schemes should use a wide range of assessment types that allow students to demonstrate a wider range of capabilities than is achieved by the current, fairly limited, end-of-course written assessments. This includes disciplinary knowledge and the ways of thinking; and the ability to apply both knowledge and ways of thinking in meaningful ways. We recommend that consideration is given to alternative and more varied forms of assessment – such as open book exams, observations of work and low-overhead teacher assessed grading - so that any washback has more positive effects on teaching and learning.

f. The IOP also recommends that assessment is not used to drive change in schools and should not be used to check up on teacher assessment as it adds a burden to both students and teachers without a proportional improvement in learning. See question 40.a – 40.h.

40. What more can we do to ensure that: a) the assessment requirements for GCSEs capture and support the development of knowledge and skills of every young person; and b) young people's wellbeing is effectively considered when assessments are developed, giving pupils the best chance to show what they can do to support their progression?

a. The IOP submits that a summative assessment system, based on written exams that comprise a limited number of styles of assessment is not contributing effectively to the listed purposes. These exams provide a system for producing grades and school rankings; however, it is not providing rich information on all the capabilities a student might have because the assessments test a very narrow range of capabilities. Performance in the assessment provides only limited information about students' strengths and as a result many students do not get opportunities to demonstrate some of their capabilities, because they are not assessed in the current system. This all means that the students who are most rewarded are those who are successful in knowledge-based tasks.

b. Most assessments rely on coded answer questions or short answer-type questions although these are sometimes structured into a longer question. This style of assessment does not reflect the ways of thinking within physics or the other sciences post-secondary education. Additionally, this style of assessment has forced teaching to become overly reliant on coaching students to perform well in such tests, and teaching has become concentrated on short-term memorisation of information and techniques.

c. What is assessed is often what is easy to assess; therefore, what is taught and learned is what is easy to assess rather than what is important. Specifications are overly focused on minutiae rather than developing coherently deep understanding of some big important ideas within a discipline. Overall, this has the perverse effect of essentially outsourcing the design of what is taught in the classroom to exam boards. We recommend that the written curriculum is defined and developed in a principled way based on what is seen as important for students to know and be able to do. Assessments should then be developed to, as best as possible, assess those capabilities. See the IOP's response to question 54 for further detail on the role of exam boards.

d. Many GCSE teaching schemes begin to focus on the ability to successfully answer GCSE-style questions from the outset. Given the narrow range of assessment types described above, this results in students becoming highly proficient in a narrow range of capabilities; and trained in the ability to answer a narrow range of question types. Whilst that may make student successful in GCSE exams, it doesn't necessarily result in high quality and deep learning of subject matter; or in a broad range of capabilities (those that are not assessed tend not to be taught or learnt).

e. Whilst it is important that students have some experience of public exams at 16, it is hard to justify, in terms of their learning outcomes, the amount of time that students spend preparing for and sitting the current GCSEs.

   Similarly, there are good reasons for students sitting a terminal assessment at the end of the course: to inform them about their strengths, to reward them for their effort, to ensure that they have covered the material and to provide a lasting record of their achievement. However, it does not necessarily require the scale or the high stakes (of assessing both the school and the pupil) of the existing public examination system. The current system is time-consuming, expensive, stressful and, as has been noted in paragraph 11-e, unreliable.

   Therefore, as discussed in 39.e, the IOP recommends investigating ways of reducing the stakes of assessment at 16 so, that pupil learning and well-being are placed at the heart of the purposes of assessments.

f. It is worth noting that some private schools have stopped entering their students for GCSEs.

g. Although this question is about GCSE, it is worth noting that the narrowing of assessment styles has also occurred at A-level. Within the sciences this emphasis has manifested itself in the loss of some important styles of assessment in the last 20 years. There is no longer an extended practical investigation; nor a practical exam that tests procedural knowledge and there is very little that tests deep conceptual understanding, comprehension, or the ability to critique an argument. The Revised Nuffield A-level physics course had seven different types of assessment at the end – each of which washed back (in a positive way) to the way in which the course was taught and learned.

h. We would like to see a major review of assessment methods that makes use of modern technology, puts trust in teachers, and focuses on each student's needs from the assessment. We recommend that consideration is given to including some forms of internal assessment in the sciences (without being overly burdensome), such as undertaking practical projects or using a form of endorsement like the implementation of the Common Practical Assessment Criteria at A-level.

Accountability system

44. To what extent, and in what ways, does the accountability system influence curriculum and assessment decisions in schools and colleges?

a. Some of the concerns in our answers to questions 39 and 40 above have arisen from the increasingly high-stakes nature of linking assessments to school accountability. There is pressure on schools, school leaders and teachers for their students to perform well in exams, which has led to some of the behaviours described above and to schools gaming the system both in terms of their provision and the options that they offer students.

b. The IOP recommends that school accountability should primarily occur through an effective system of inspection rather than relying so heavily on student performance in external exams. Student assessment should focus on what is valuable for the students rather than on as a primary means for making schools accountable. Clearly, exam results can inform accountability but should not be the main tool.

c. We recommend a review of school accountability measures and a move to disentangle direct measurements of school performance from the raw results of student performance.

d. We recommend that the DfE commission research to look at whether assessment methods and the existence of high stakes tests correlate with student outcomes, student wellbeing and teacher retention. For example, in Canada there is very little high stakes testing and teachers are trusted; there is no evidence to suggest that student outcomes are reduced – indeed, they may be improved because recruitment, satisfaction and retention of teachers is better.

45. How well does the current accountability system support and recognise progress for all pupils and learners? What works well and what could be improved?

a. The current close link between accountability of schools and assessment for students results in some undesirable gatekeeping. We have already discussed in 29-d that two thirds of schools select the students who are allowed to follow the three separate sciences ("triple science") at GCSE based on prior attainment. We have recommended that all students should have access to a route through the GCSEs in the sciences that provides them with the advantageous features of the current "triple science" route. That is a course in which the sciences are:

    - Specified and examined separately with their own grade
    - Timetabled separately with at least two identified lessons in each of biology, chemistry, and physics
    - Allocated a separate teacher who is generally a specialist in that subject.

b. Gatekeeping also occurs with entry onto A-level courses – either directly or indirectly (by self-selection based on advice that a particular course will be more difficult). One reason for this selection or self-selection is that physics is seen as a route to high tariff university courses. Consequently, in some schools, students who are likely to achieve a C, D or E in physics feel (or are) discouraged from choosing physics. As well as the direct effect on students who might have benefited from taking physics A-level but were debarred, this is detrimental contributes to a general perception that physics is 'difficult' (which it is not) and that physics is not for people like them as either an A-level or a pathway to physics-related apprenticeships.

T-levels

48. Are there particular changes that could be made to the following programmes and qualifications, and/or their assessment that would be beneficial to learners: a) AS/A level qualifications b) T Level and T Level Foundation Year programmes c) Other applied or vocational qualifications at level 3 d) Other applied or vocational qualifications at level 2 and below

a. Overall, given T-levels remain comparatively new (with very small numbers on T-level Science, for example, and limited progression data), we believe the priority should be making incremental improvements to tackle key barriers, rather than more radical changes that could deprive the technical education system of much needed stability. However, the IOP recommends a fuller review in the round of the extent to which T-levels are meeting the needs of young people and employers once they are more mature – likely in three to five years.

   The IOP has noted that the current T level Science includes comparatively less physics content, relative to biology and chemistry. This may have the potential effect of reducing access to physics-related pathways and employment for those taking T-levels, but whilst numbers remain small and the qualification still comparatively new, it is hard to evaluate. We recommend that this is kept actively under review as the qualification matures.

b. While recognising that it is still early in the delivery of the T Level Science, we have some concerns about the geographic distribution of provision both in and of itself, and in relation to physics-powered industry. Ultimately, geography should not be the key determinant of whether someone can take T Level Science. We urge the Department for Education to collect and monitor data on the geographical distribution of providers, and availability of placements, to the level of occupational specialisms.

c. Progression opportunities from T Level Science into higher education programmes remain unclear. Many university departments are yet to state whether they will accept T Level Science achievers and others do not include it in their entrance criteria. Anecdotally, IOP has heard that to consider T Level Science upon entry, physics admissions tutors are requesting additional qualifications from applicants, or mandating that applicants undertake a foundation year so that they can be taught the maths and physics to the level required for undergraduate study. We recommend that there is monitoring of departments within Higher Education Institutions (HEIs) that list T Level Science as an acceptable entry qualification and the number of learners that are enrolled with a T Level at that institution.

d. For the technical education system to thrive, T Levels should primarily be seen, and marketed, as a pathway to occupations or further technical education, as per their original intent, with option for transfer to higher education with an appropriate bridging qualification. We understand that many T Level students are, however, viewing the pathway as a direct entry to higher education.

The early proposals for T Levels included a transition programme that would support T Level students who wished to progress to higher education, however the idea of a transition programme appears to have been dropped. A transition route approach may have to be revisited to bridge the gap between T Level Science, which was not designed for direct entry to higher education, and the entry requirements set by HEIs. We are concerned that if progression opportunities are less favourable, T Levels may be less attractive to those students who do not want to commit at 16 to a specific technical occupation whereas academic options tend to leave career options broader at this point.

e. The IOP is supportive of a post-16 qualifications landscape that is coherent and equitable and prepares young people to progress into a range of careers and further and higher education opportunities in the physical sciences, and more widely. We do however remain concerned that removing BTEC Applied Science qualifications will create a provision gap that will lead to a reduction in numbers of students studying on science pathways at Level 3 and beyond. This provision gap will disproportionately impact students from disadvantaged backgrounds. At this stage AAQs remain too new to make comment on whether they adequately and equitably fill some of the gap.

f. The IOP has a specific residual concern around the most physics-rich occupational specialism in T-level Science being in metrology, where there were no starts in the 2022-2023 or 2023-2024 cohorts (with DfE data showing that 100% of students chose the laboratory sciences occupational specialism in 2023-24). We recommend that the Department for Education closely monitors the uptake and provision of the metrology occupational specialism and reviews whether it is meeting young people's and employers' needs.

g. T-Level Science progression pathways need to be clear to students, their parents, carers and other influencers, such as teachers, so that young people are fully informed of the qualifications and occupations available to them when making career-based choices. Employers need to be aware of the education landscape so they can also make informed decisions when planning their workforce development strategies. To gain a deeper understanding of whether T-Level Science is meeting the needs of both students and employers requires data collection, analysis and prompt publication. In addition to our comments about data in this section, we urge DfE to share progression case studies and make T-Level Science student destination data available at the level of occupational specialism.

49. How can we improve learners' understanding of how the different programmes and qualifications on offer will prepare them for university, employment (including apprenticeships) and/or further technical study?

a. Provide young people with a broader range of opportunities and experience up to 16, see the IOP's response to question 39.

b. Learners' understanding of how different programmes and qualifications will prepare them for university, employment (including apprenticeships) and/or further technical study can be improved by contextualising the curriculum. Building awareness of diverse role models and their career paths, examples of physics being applied in different sectors, including highlighting local/regional sector strengths and opportunities, should be embedded within everyday learning and teaching. See IOP's response to question 23, c-d.

c. Provision of support is required for those teaching physics and those tasked with careers support to upskill them about the routes into physics-related apprenticeships and physics-powered sectors. Evidence shows that teachers lack confidence and knowledge in this area which means they are currently less able to develop learners' understanding and awareness of different pathways to economically crucial occupations in physics-powered sectors.

51. Are there additional skills, subjects, or experiences that all learners should develop or study during 16-19 education, regardless of their chosen programmes and qualifications, to support them to be prepared for life and work?

a. Employers ask for young people to be more "employer ready" with skills such as communication, presentation, digital and teamwork. We recommend that students are given plenty of opportunities to experience and develop these skills through a mix of technical, manipulative and creative activity during their mainstream schooling both up to 16, and beyond into 16-19 education.

b. Schoolteachers, parents and carers play an important role in shaping perceptions around study and careers pathways, IOP research shows they tend to perceive university as a more valued route, and don't feel confident about recommending alternative technical pathways, for example, apprenticeships. Ensuring young people are regularly and meaningfully exposed to local employers and technical education providers so that apprenticeships are better understood as a viable route into jobs is crucial and Provider Access Legislation will need sufficient enforcement.

54. Do you have any further views on anything else associated with the Curriculum and Assessment Review not covered in the questions throughout the call for evidence?

Curriculum oversight body

a. The IOP would like to see a mechanism established for the development of curriculum content within each subject that brings in expertise from curriculum designers and subject specialists. In the current system, the broad criteria are defined by the Department for Education and the curriculum in each subject is, in effect, designed by exam boards. There should be more consideration given to what is important within a subject or discipline as well as what can be assessed.

b. The way that a subject is represented and assessed is largely in the hands of the exam boards (and a small number of examiners within each one). Quite rightly, the interests and priorities of these exam boards relate to the validity and reliability of assessment schemes and items rather than the quality of learning in a subject or the impression that students acquire of that subject.

c. In this system, the representation and reputation of physics is hugely affected by decisions made by a small number of examiners. Specifically, physics has recently earned the unwarranted reputation of having lots of facts to be learned. And recently we have seen exam papers that have been distressingly challenging for students.

d. We see a need for there to be a guardian of each school subject to ensure that specifications and assessments fairly represent the nature of the endeavour of the subject. This could be achieved through the establishment of a new, independent curriculum oversight body that works at a subject level. Such a body (or an alternative structure) would:

    - draw on subject and pedagogical expertise to ensure that each school subject contributes clearly to the overall aims of the curriculum.

    - ensuring that the appropriate content is taught at the appropriate age/key stage and that there is developmental coherence between the educational phases and key stages.

    - ensure that the curriculum focuses on the big and important ideas of each discipline and provides space for teachers to develop deep knowledge and capability that is of lasting value.

    - be supported with long-term commitment and investment to ensure stability and empower it to collect and respond to evidence of effective practices of curriculum design and pedagogy, taking account of any technological developments that can aid teaching or assessment.

    - work with Ofqual to ensure that assessment schemes test what is important rather than what is easy to assess.

- ensure that there are opportunities for all students to experience a wide range of both academic and technical subjects up to the age of 16 and make informed decisions at 16 of which path they will follow.

- commission research – to feed back into the system to drive continual improvement.
- provide long-term stability for the curriculum.

Grading severity

a. Since the 2006 report Relative Difficulty of Examinations in Difficult Subjects, there has been clear evidence that that some subjects are graded more severely at A-level than others. Severely graded subjects include maths and physics and the other sciences. One way of thinking of this is that, in order to get a given grade, the value added by sixth form study in physics has to be more than, for example, English or geography. So, a student achieving straight grade 7s at GCSE across all subjects is likely to end up with a lower grade in physics than in geography. This is not about aptitude, subject accessibility or general perceptions of difficulty; it is about setting the grade boundaries too high in severely graded subjects.

b. Clearly, if students are aware that taking physics might cost them a grade, this will influence their decision away from taking the subject.

c. There have been lengthy discussions and exchanges with Ofqual. In November 2018, the Ofqual board decided to not make any changes to the grading in physics and the sciences. However, they did undertake to address the issue within modern foreign languages. The IOP consider this to be a regrettable decision and wrote to the chair of the board in 2019.

d. It remains the IOP's view that changes should be made to grade boundaries in subjects to ensure that there is comparability of grading between different subjects. A review of assessment and grades at A-level is an ideal opportunity to make that change. So, we recommend taking the opportunity of the curriculum and assessment review to review grading comparability at A-level and make adjustments to make subject grades more comparable.

Professional development

a. The IOP strongly recommends that any review of the curriculum is supported by sufficient funding for teachers, teacher trainees, and school and college technicians to access and take part in professional learning on teaching and supporting the new curriculum.

Data

a. The IOP notes that it has become increasingly difficult to get access to data about schools and colleges, specifically the National Pupil Database and the School Workforce Census. As such, we have been unable to update some of our statistics on pathways through schools and colleges since 2018. Such data and its analysis is extremely helpful in understanding student behaviours and the causes of those behaviours. We recommend that the DfE works with the Office for National Statistics to provide more straightforward ways for researchers and data analysts to access NPD data in an ongoing way.