Course Report 2017 – External Assessment

Subject	Engineering Science
Level	Advanced Higher

The statistics used in this report have been compiled before the completion of any Post Results Services.

This report provides information on the performance of candidates which it is hoped will be useful to teachers, lecturers and assessors in their preparation of candidates for future assessment. It is intended to be constructive and informative and to promote better understanding. It would be helpful to read this report in conjunction with the published assessment documents and marking instructions.

Section 1: Comments on the assessment

Component 1: Project

All verified centres verified used the SQA project provided on the secure area of SQA's website — meaning that the instruments of assessment used were valid. Although there is only one assessment task, it is open-ended, to provide personalisation and choice for the candidate. Care should be taken to ensure that a task appropriate to the level is selected. In addition, candidates should ensure that it is possible to access enough appropriate information to carry out sufficient research.

Of the centres verified, all were assessing to National Standards. This would indicate appropriate use by centres of the available understanding standards materials.

Centres should ensure that candidates are not given excessive guidance, and should ensure that it is being administered as a national assessment. Where guidance was given to individual candidates (group support is not permitted), this should be reflected in the mark allocation to ensure equity and fairness of assessment of all candidates.

Centres are reminded that this component is part of a national assessment, and that the approach used should be one where no teacher support is given unless it is explicitly required by the candidate. In such cases, marks should be deducted to reflect this, and this support should be noted on the marks sheet to justify assessment judgements.

Centres are reminded that the assignment should be carried out under open book conditions, but supervised to ensure that the work presented is the candidate's own.

Component 2: question paper

The question paper consists of two sections totalling 60 marks. The first section consists of a number of questions worth 3–5 marks, each requiring specific unit knowledge and understanding. The second section of the paper consists of two extended questions; both require integration of unit knowledge and understanding.

The question paper performed in line with expectations for the top third of candidates; a number of candidates found the overall level of demand testing, both in terms of content and also in terms of time. The question paper is intended to act as a discriminating element in course assessment. Across the cohort, all question elements were answered fully by at least one candidate. A significant number of candidates were not prepared for this question paper, scoring less than 30%.

Section 2: Comments on candidate performance

Areas in which candidates performed well

Component 1: project

Candidates performed particularly well in the construction/simulation areas of the assignment as well as the inclusion of code — these are the parts of the assignment where marks are more accessible. Flowcharts and mechanical system designs were also relatively well done.

Component 2: question paper

Question 1(b): Candidates were clearly familiar with this form of project management tool and completed the Gantt chart from a precedence table, positioning time requirements for each task correctly. However, a number omitted the float available for tasks, which should be included at this level, as shown in the marking instructions.

Question 2(b): A high number of candidates were able to identify intermittency of supply as an engineering issue; fewer were able to discuss how this might be overcome, despite the information mentioned in the introduction to the question.

Question 4: Second moment of area calculations for compound cross-sections appeared to be well understood.

Question 5: Use of nodal analysis (the application of Kirchhoff's Current Law at the node and, subsequently, the application of Ohm's law to each resistive element controlling a current to the node) was generally better understood and well-attempted by a greater number of candidates than last session

Question 6: A non-standard representation of a cantilever with a point-load applied at its free end. The majority of candidates selected the appropriate deflection formula to work with from the Data Booklet. Mistakes were made with the effective length of the cantilever. Where hollow sections are used, candidates should check the Data Booklet to see if it is a standard section with a given value for second moment of area. This is quicker than calculating a value by subtraction, using the formula for the second moment of area of a rectangle and the stated dimensions.

Question 7(b): Most candidates were able to identify the effect on transmissible power, although fewer were able to clearly explain the effect that they thought would arise, as given in the marking instructions.

Question 8(a): Candidates were generally well-prepared to produce a shear-force diagram for a beam under load. A calculation error for one of the reactions does not mean that credit for the diagram becomes impossible. Centres should advise candidates to check that the sum of the reactions is equal in magnitude to the sum of the loads whenever a beam is supported at two points.

Question 9(a): Most candidates were able to establish values for resistance and capacitance necessary to produce the stated frequency of sine wave. However, fewer recognised that the other two resistors have to have a particular ratio (2:1) to produce a gain of 3 for an oscillation to be stable. If the ratio is higher, the oscillation grows in amplitude until it saturates: conversely, if the ratio is lower, the oscillation reduces in amplitude until it disappears. This is an idealised circuit, but candidates are expected to recognise that this resistor network is significant to the way that the oscillator behaves.

Question 9(c): Despite 3D force calculations being relatively new content, this question was attempted relatively well. The angled force was resolved into horizontal and vertical components more successfully than last session. As stated in last session's report, clear free-body diagrams tended to assist the development of correct moment equilibrium equations. It is not enough to state the numerical value of the reaction angle; somewhere, the sense of the angle must be clear diagrammatically in relation to the geometry of the system.

Areas which candidates found demanding

Component 1: project

Please note that the project is structured section-by-section for assessment purposes only. Candidates may structure their report in any way they choose — marks can be awarded for each section from any part of the report. However, to aid assessment, it may prove helpful to treat Sections 1 and 2 (Research and Analysis and Producing a Specification) as one holistic section and Sections 4 and 5 (Mathematical Modelling and Constructing / Simulation) as another.

Aspects of the assignment that candidates demanding were:

Sections 1 and 2

Candidates should analyse the problem, detailing top level systems diagram, subsequent sub-systems diagrams, inputs, outputs, etc.

Once the research factors have been identified, candidates should plan how they are actually going to research them (internet, library, site visits, telephone interviews, questionnaires, etc). They should provide a detailed plan of exactly what information they are looking for — for every factor. They should then carry out the research, providing evidence of this, referenced quotations from websites or books, completed questionnaires, collated results, etc. Results of the overall research should be provided, drawing meaningful conclusions, relevant to the assignment task. They should then provide a detailed specification drawn from their relevant research.

Section 3

This section should plan the progress of the project and should be regularly reviewed to ensure that individual milestones are being met. This section should include a detailed list of required resources (and how they are going to be sourced), a Critical Path Analysis to

identify the order in which the work will require to be carried out, and a Gantt Chart, detailing timescales, individual milestones, etc. The project plan should include evidence of the continual review (annotations, highlights, etc) along with any subsequent adaptation as a result of the reviews.

Sections 4 and 5

Mathematical Modelling does not just refer to mathematical calculations: it could reflect techniques such as circuit simulation, etc. However, **it must reflect learning in the course or beyond**. Any mathematical calculations must be of a level at least of the demand of Higher Mathematics. Page 31 of the project provides a possible list of activities. The results of the modelling must be relevant and applied to the problem. Any calculations should be appropriately annotated to ensure that the process makes sense to the reader. A detailed description of how simulated sub-systems could be integrated should be included.

Section 6

Although no marks are awarded for testing the solution, it would be extremely difficult to compile a detailed evaluation without it. The evaluation should be clear and detailed. It should be of a similar literacy level to Higher English. The evaluation should reflect on the solution when compared to the specification (sub-system by sub-system) and should also evaluate progress through the assignment by reflecting on the project plan and record-of-progress.

Section 7

The report should be well presented, in a logical order and should read well. It should make sense to the reader. Diagrams and other figures should be appropriately titled and referred to in the text. The record-of-progress should be very detailed and reflect the level of Advanced Higher.

Component 2: question paper

Question 1(a): This is content found in the Project Management unit. Candidates generally found it difficult to define indirect-costs and on-costs associated with a project, and to identify examples of each. Definitions are supplied in the marking instructions. NB: candidates should also understand capital-costs and direct-costs.

Question 2(a): The majority of candidate responses lacked any depth beyond that expected at Higher level. Very few candidates made significant use of the information supplied in the extract, which was intended to help them respond to the question. The command word ‘Discuss’ was used, and may be used in future question papers. Candidates should be aware of the moves in public policy, and hence engineering design, towards what are presently considered sustainable technologies — key areas being energy generation, transportation, manufacture, communication and infrastructure.

Responses to questions on this area of the course must show progression from National 5 and Higher, so rather than statements of specific positive and negative effects, a response should be a balance of pros and cons across the identified areas, as suggested in the

marking instructions, and should be related to the area highlighted in the question — energy generation in this case.

Question 3: The majority of candidates recognised that this question involved the General Beam Bending equation. However, most opted for $\frac{\sigma}{y} = \frac{M}{I}$ and did not find a solution: few recognised that the distance from the centre of the drum to the centreline of the wire is a radius of curvature, R, and so $\frac{\sigma}{y} = \frac{E}{R}$ is the direct route to establishing the stress in the wire. The recognition of what the term 'radius of curvature' represents is perhaps underemphasised in teaching.

Question 7(a): Candidates were able to calculate the lower value of tension in the rope, using the information supplied in the question. However, when calculating power there was a significant recurrence of each of the following three errors:

- not finding the difference between the two forces, which act at the same radius, when calculating torque
- either omitting the radius, or using the diameter, of the pulley within the calculation
- not dividing the given rotational speed by 60 to find the rotational speed in revs s^{-1}

Candidates may be clearer about the first point if they consider each force separately: one produces a clockwise torque, while the other produces an anticlockwise torque. The resultant torque is therefore the difference between the two.

Question 8(b) and 8(c): Both questions were intended to identify the most able candidates. Very few candidates attempted Q8(b)(ii) successfully. It should be noted that those candidates attempting part (c) should have recognised from their response to Q8(a) that the shear force is zero at the right-hand support, as well as at a point to the left of the 16 kN load. Local maximum and minimum values of bending moment occur when the shear force is zero. Values of bending moment would have to be calculated at both to establish which has the larger magnitude.

Question 8(d) This question was poorly answered: the information in the box states that the glass requires an AC voltage, the amplitude of which controls the transparency. The DAC will be supplying a fixed, DC, voltage for a given transparency. The inverter, controlled by a DC voltage, produces an AC voltage. (Note that a rectifier would be the device commonly used to convert AC to DC).

Question 8(e) This type of question was relatively common in AH Technological Studies and can be found in past papers. A similar question also appeared in the specimen paper. Calculations were poorly done and a significant number of candidates did not include a second stage op-amp to invert the output of the summing amplifier.

Question 9(b) The question was intended to identify the most able candidates. Very few candidates attempted Q9(b) successfully. It is exemplified in the specimen question paper. The resistors form a potential divider, where the two end-point voltages relate to the graphs, and the candidate must recognise from the circuit that the switching point on the graphs occurs when the voltage between the two resistors reaches zero. Nodal analysis at the point between the two resistors then allows the required resistance to be calculated. The capacitance is calculated by identifying the op-amp configuration as an integrator and by

noting the time it takes for the output voltage to reduce by 20.4 V, when the input voltage is a constant 13.4 V, as shown in the marking instructions.

Question 9(d) Relatively few candidates attempted either part of Q9(d). The first part of the question involved the interpretation of a nested loop. Several candidates attempted to draw the output of the microcontroller pin (varying PWM), rather than the speed of the motor. The second part of the question tested understanding of microcontroller-generated proportional control; only half the candidates attempted the question and few answered correctly.

Section 3: Advice for the preparation of future candidates

Component 1: project

Please note that this component is part of a national assessment and the approach used should be one where no teacher support is given unless it is explicitly required by the candidate. In such cases, marks should be deducted to reflect this and this support should be noted on the marks sheet to justify assessment judgements. This assessment is open-book in nature — otherwise it should be conducted in controlled conditions. In addition, colleagues should ensure that **all** work is the candidate's own. This means that the assignment must not be completed at home.

The assessment is a task with many possibilities available at each stage. As a result, a variety of solutions would be expected within a cohort, with a range of presentation styles and structures. Pre-built models, either to use in the assessment or to exemplify possible solutions, are not permitted. Templates for candidates to use are also not permitted.

Assessors should share the marking guidelines with candidates, and candidates should then structure *their* solution in any way they see fit. Marks can be awarded for sections, regardless of where they are in the structure of the report.

Component 2: question paper

Working in calculations should not be rounded until a final value is reached, and candidates should follow the guidance on the use of significant figures (as given on the front of the question paper) when writing their final answer.

In the context of a question, to gain full marks, calculated values must include correct units and engineering notation for the numerical value quoted.

To expect to do well in the examination at Advanced Higher level, candidates must be prepared to devote significant time to their own reading in the subject to move their own subject knowledge beyond Higher level content, particularly in relation to course themes.

Whilst it was pleasing to see that the conditions of assessment for coursework were adhered to in the majority of centres, there were a small number of examples where this may not have been the case. Following feedback from teachers, we have strengthened the conditions of assessment criteria for National 5 subjects and will do so for Higher and Advanced Higher. The criteria are published clearly on our website and in course materials and must be adhered to. SQA takes very seriously its obligation to ensure fairness and equity for all candidates in all qualifications through consistent application of assessment conditions and investigates all cases alerted to us where conditions may not have been met.

Grade Boundary and Statistical information:

Statistical information: update on courses

Number of resulted entries in 2016	75

Number of resulted entries in 2017	79

Statistical information: Performance of candidates

Distribution of course awards including grade boundaries

Distribution of course awards	%	Cum. %	Number of candidates	Lowest mark
Maximum Mark -				
A	8.9%	8.9%	7	109
B	16.5%	25.3%	13	94
C	27.8%	53.2%	22	79
D	6.3%	59.5%	5	71
No award	40.5%	-	32	-

General commentary on grade boundaries

- While SQA aims to set examinations and create marking instructions which will allow a competent candidate to score a minimum of 50% of the available marks (the notional C boundary) and a well prepared, very competent candidate to score at least 70% of the available marks (the notional A boundary), it is very challenging to get the standard on target every year, in every subject at every level.

- Each year, SQA therefore holds a grade boundary meeting for each subject at each level where it brings together all the information available (statistical and judgemental). The Principal Assessor and SQA Qualifications Manager meet with the relevant SQA Business Manager and Statistician to discuss the evidence and make decisions. The meetings are chaired by members of the management team at SQA.

- The grade boundaries can be adjusted downwards if there is evidence that the exam is more challenging than usual, allowing the pass rate to be unaffected by this circumstance.

- The grade boundaries can be adjusted upwards if there is evidence that the exam is less challenging than usual, allowing the pass rate to be unaffected by this circumstance.

- Where standards are comparable to previous years, similar grade boundaries are maintained.

- An exam paper at a particular level in a subject in one year tends to have a marginally different set of grade boundaries from exam papers in that subject at that level in other years. This is because the particular questions, and the mix of questions, are different. This is also the case for exams set in centres. If SQA has already altered a boundary in a particular year in, say, Higher Chemistry, this does not mean that centres should necessarily alter boundaries in their prelim exam in Higher Chemistry. The two are not that closely related, as they do not contain identical questions.

- SQA's main aim is to be fair to candidates across all subjects and all levels and maintain comparable standards across the years, even as arrangements evolve and change.