A-LEVEL

PHYSICS

7408/3BC Engineering Physics
Report on the Examination

7408
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General Comments

It was pleasing to see that many students were well-prepared for the examination. There were many scripts where calculations were approached confidently, and students were able to apply their knowledge and understanding to the qualitative questions with well-written and carefully thought-out answers.

Assessment Objective 3 in the new specification requires students to analyse, interpret or evaluate information, and make a judgement or come to a conclusion. Questions 01.4, 02.2, 02.4 and 03.3 were of this nature, and they proved to be demanding. In questions 01.4, 02.2 and 03.3 no hints were given as to how the questions should be approached.

Some students let themselves down by a general lack of attention to detail. In questions 1 and 2, for example, they wrote 'inertia' for 'moment of inertia', and missed out 'angular' before acceleration, momentum or impulse.

Even though examiners take pains to interpret poor handwriting, marks can still hang on whether an examiner can distinguish key words.

Over one quarter of students wrote level three answers in question 4, and there were some very good 'textbook' answers.

Question 1

01.1 About half of all students scored 2 marks here. The rest mainly wrote 'inertia' instead of 'moment of inertia' as being analogous to mass.

01.2 The majority of students were successful here. Those who did not get the mark either calculated only the moment of inertia of the trolley and load, or failed to square the 35 m.

01.3 If this question had been set in a linear context, with a velocity-time graph in place of an angular velocity against time graph, it is likely to have been answered well. Only about 60% of students scored any marks at all. A common error was to oversimplify the situation and use average angular speed = total angular displacement / total time.

01.4 The majority of students scored the first mark for stating that the moment of inertia increases as the trolley moves away from the axis, but that is as far as they went. There were good answers using $T = I\alpha$ with T constant and I increasing, but many tried to use conservation of either angular momentum or kinetic energy.

Question 2

02.1 This was a straightforward calculation of torque which was answered well.

02.2 This question, however, proved much more demanding, with only just over one quarter of students gaining any marks. Gears are not on the specification, but the scene was set carefully, and all relevant information was given. Students who realised that power ($T\omega$) or work ($T\theta$) is transferred from gear B to gear C, or that the force on the meshing teeth of gears B and C was the same, gained marks. Many students tried to use $T = I\alpha$ and got side-tracked into relative accelerations or moments of inertia of gears B and C.

02.3 The calculations for this question were done well.

02.4 Students were asked to refer to 'angular impulse', and an easy mark could be scored simply by defining angular impulse as change in angular momentum. There were some good answers, but some students got as far as saying there would be a high torque, then failed to go on to relate this high torque to a high force for the last mark.

Question 3

03.1 The majority of students scored 2 marks here for calculating the final pressure, but the calculation of final temperature proved more difficult. A minority of students thought the temperature remained constant. The expected route to the temperature was to use $PV/T = constant$, but a very small number of students used $T \times V^{\gamma-1} = constant$, which is correct, but more likely to incur an arithmetical error.

03.2 Here, the mark scheme required students to define an adiabatic process and then state that there was little time for heat transfer to take place when the pressure is rapid. Only 30% of students scored both marks.

03.3 Students who wrote the best answers to this question took the hint from the space given above the answer lines to draw a p - V diagram, clearly showing adiabatic and isothermal curves for compression, through a fixed volume change, starting from a common point. In their written answers they then referred to the areas under the curves. All too many students tried to argue their way through this by applying the first law of thermodynamics to both processes, and got nowhere.

Question 4

In this level-of-response question, students were asked to compare a theoretical Otto cycle with a real petrol engine cycle. Just under half of all students scored 4, 5 or 6 marks, indicating a good understanding of the differences and the reasons for the differences, and also an understanding of why the work output is lower than the theoretical cycle predicts. It is likely that these students and/or their teachers had read the Engineering Physics teaching guide to be found on the AQA website.

For level 3, the differences between the cycles needed to be given matching reasons, but for levels 1 and 2, candidates could pick up marks for any points taken from the lists given in the mark scheme. There were some excellent answers at the top end, but at level 1 some students concentrated on what went on in the cycles rather than comparing them. Simply by noting the lower peak pressure, the induction/exhaust loop, the rounded corners and the smaller area, students could achieve credit. Common misconceptions were:

- the theoretical cycle is 100% efficient;
- the theoretical cycle doesn't lose heat, whereas a real engine does.

Question 5

05.1 Half of all students scored the 1 mark for this question.

05.2 Only about one third of all students scored any marks at all for this question. Of these, many were able to calculate the COPref from the absolute temperatures, but could get no further because they had little idea of the meanings of Q_C, Q_H, and W in the equations in the specification and Data Booklet. Common errors were:

- not changing temperatures from °C to K when calculating the COP;
- using the formula for the maximum efficiency of a heat engine rather than the idea of COP;
- to find the input power, multiplying the COPref by 100 or dividing 100 by the COPref;
- mixing temperature and energy in the same equation e.g. $W = 272/\text{COPref}$.

Some students may not have been aware that the formula for calculating the COP using temperatures is in the specification, but not in the Data Booklet.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.