

New Zealand's Next Top Engineering Scientist 2010

Results and Examiner's Report

Examiner's Report

This is the second year of this competition and the general standard of entries was, not surprisingly, higher than that of last year. The problem was, of course, completely different, to that of last year's one. However, it still required some sound problem-solving skills typical of those needed and employed in the Department of Engineering Science. We hope that the participants all enjoyed the competition and learnt something in the process.

As in last year, the problem specified was very open-ended and challenging. For example, the question did not specify whether a return journey had to be considered, but if you are going to take a person to Mars, one should consider how they are going to get back! The actual answer was not, in fact, that important to the examiners. What was of interest was the process followed in coming up with the answer, and the ability of the teams to put their ideas together in a well structured document and develop and present quantitative arguments to support their conclusions. It was of course not possible for all of the issues and questions to be addressed in the time available – this was all part of the challenge.

The entries were initially examined by four members of the Department of Engineering Science. Each of these members compiled a short list of the entries they considered to be the best. This entire short list was then independently examined by two Professors in the Department of Engineering Science, one of whom is the current Head of Department. Both of these judges independently came to the same conclusion as to the winning entry. After further deliberation, the runners up and the highly commended list of entries were then identified. All judging was done using only the team ID number for reference. Only once the results were decided did the judges learn the identity of the winning teams and schools.

Included below is the list of results showing the winners, runners up and highly commended entries. This list is followed by some brief specific comments for each entry that did not make the results list.

Overall Winner (\$6000)

Team 1004 from Westlake Boys' High School

Danny Kwok, Jeffrey Mei, Benjamin Tan, Yuanye Xu

Runners Up (\$2500 to each team)

Team 1015 from Hawera High School

Dillon Manuirirangi, Bailee Riddick, Stephen Greig, Shernal Prasad

Team 1084 from Birkenhead College

Owen Dillon, Tsun Hei Tai, Alex Shegay, Ngaio Garcia

Highly Commended

Team 1039 from Trident High School

Haylie Griffen, Shane Van Bergen, Toni Attwood, Wieland Kuhn

Team 1045 from St. Cuthbert's College

Harim Lee, Jimin Kang, Vicky Tai, Elynna Yang

Team 1053 from Westlake Boys' High School

Jakov Biondic, Mohammad Sarrafzadeh, Callum Welch

Team 1054 from Whangarei Boys' High School

Felix Saparelli, Matthew Pearce, Tobias Barker, Zak Holdaway

Team 1069 from St. Peter's School

Lance Henderson, Sandra Mitchell, Richard White, Dijon Hoogeveen

Team 1095 from Nelson College

Timothy Leaper, Rodney Martin, Reuben Olorenshaw, Mack Delaney

Team 1108 from Christ's College

Alexander Donaldson, Alex Kendall, David Bellamy, Campbell Taylor

Specific Comments:

- 1001 Overall a nice study. Team consider both transport and crew survival, which is good. The report would have benefitted from the structure suggested in the guidelines.
- 1002 DNS
- 1003 Very thorough. Well thought out study. Good use of resources and safety margins. Nice discussion of assumptions and limitations. A couple of shortcomings: although a return mission is discussed calculations seem to be for a one-way trip.
- 1004 WINNER
- 1005 Report nicely considers the relative distance between Earth and Mars, as well as how fuel can be produced using martian resources for return trip and ERV.
- 1006 Well thought out study, considering the many different facets of the mission, eg. Propulsion, crew survival, some of the fuel computations. Did not take into account a return journey. A nice effort.
- 1007 Very nice study, carefully thought out with well conducted calculations. Also, novel consideration of a range of different propulsion mechanisms. Minor criticism, return journey not considered.
- 1008 An interesting report which considers some of the important elements of a man Mars mission - although the computed fuel requirements seem to be a little on the light side.
- 1009 An interesting and well written report which uses a smart approach of scaling up from the moon missions. It would have been nice to have a few more details with regards the values used in some of the computations.
- 1010 Very nice effort which considers many facets of the mission, with promising (although slightly flawed) computations for the fuel requirements.
- 1011 DNS
- 1012 A grade report, which considers many features of the mission, including complexities such as fuel consumption. Also a wide range of very respectable literature has been reviewed.
- 1013 A brief report, but one which discusses some of the important considerations for a man to Mars mission.
- 1014 An interesting report which discusses novel plasma propulsion methods and considers many of the important issues for a manned Mars mission.
- 1015 RUNNER UP
- 1016 Nice, well written and interesting report. The authors only considers a one-way trip, however, this would require extremely courageous astronauts.
- 1017 A nicely thought out report which considers many of the important considerations relevant to a manned mission to Mars.
- 1018 An interesting report which considers some novel methods for powering the craft (eg. Solar power) during the inter-planetary journey.
- 1019 A nicely written, well though out report. Although the computed fuel consumptions look to be a little on the small side.
- 1020 An Interesting report which addresses many of the important challenges facing a manned mission to Mars.
- 1021 An interesting and well written report with convincing calculations.

- 1022 A brief but interesting report which deals with some of the important considerations relevant to a manned Mars mission.
- 1023 An interesting report which consider the many different aspects of a manned mission to Mars, including propulsion options and crew survival.
- 1024 An interesting report which treats many different aspects of a man to Mars mission. Minor comment: Hohmann transfer orbit may be a better trajectory than a straight line journey.
- 1025 An interesting report which discusses some of the important issues connected to a manned mission to Mars.
- 1026 A very well written, comprehensive and interesting report. It is pleasing to see that the authors have considered the many different facets of a manned Mars mission, although the fuel requirements seem to be very light at only 300kg.
- 1027 An interesting report which considers many of the important issues facing a manned mission to Mars.
- 1028 Nice sketches, but many assumptions introduced without justification. Slightly flippant tone. No specific references.
- 1029 No citation numbers; a methodical set of calculations is provided - nice energy accounts. Analysis feels incomplete, but nevertheless a strong submission.
- 1030 Well written; careful development/explanation; nicely focussed discussion.
- 1031 It appears that this solid submission would have benefitted from additional time. Appealing choice of simplifying assumptions. Citation list feels incomplete.
- 1032 Well written. Might have benefitted from a more detailed consideration of orbit transfer. Difficult to read: dark text on dark background, avoid this. Some terms in mass calculation are missing explanation. Citation list feels incomplete.
- 1033 Starts very well: Nice introduction and explanation of fuel options. Seems to run out of steam. Would have been nice to see more quantitative analysis.
- 1034 Logical section structure, but individual sections could be more focussed and calculations more clearly explained. Did not develop initial mention of return journey. Citation list feels incomplete.
- 1035 Comprehensive discussion of spacecraft design - including assembly at International Space Station - crew, and all phases of the journey: Nicely thought out. Confident analysis.
- 1036 Nicely written, though introductory material was perhaps a little unfocussed. Calculations would have benefitted from additional commentary. No labelled citations.
- 1037 Would benefit from additional commentary in escape calculation, and explanation of sling-shot strategy. Assumptions listed in the discussion are admittedly unrealistic; might have presented a more determined attempt to address these. Interesting proposal to refuel at International Space Station.
- 1038 Made a good start, but ultimately felt incomplete: Much detail provided for escape thrust calculation, but no subsequent analysis of fuel requirements. No labelled citations.
- 1039 Nicely balanced coverage of orbit transfer strategies and corresponding calculations. Sensibly pragmatic specification of spacecraft & fuel. Very well done.
- 1040 DNS

- 1041 Nicely written, though the modelling assumptions seem unnecessarily restrictive: Fuel requirements based purely on distance, without consideration of gravitational forces. It would have been desirable to provide more discussion on the retrieval plan mentioned, or consideration of a return journey. Citation were not provided for all tables.
- 1042 Well written with clearly articulated objectives; discussion could have been more focussed in later parts. Unmanned mission to supplement fuel supplies is a compelling strategy. Reliance of cutting-edge technology may prove risky, given the stated launch time-frame. Would have benefitted from more detailed fuel calculations. Citation list feels incomplete.
- 1043 Well written with appropriate use of the literature. Focussed analysis; methodical, logical progression of calculations is impressive, even though the team notes that the results do not seem plausible. Well done.
- 1044 Although this report is well presented, it would have benefitted from more extensive analysis, and a justification of the configuration proposed. No numbered citations.
- 1045 Clearly written, with a nicely annotated bibliography. Impressive breadth of discussion, including fuel, refuelling stations, escape requirements, and the mass of shielding material. Notion of ideal mass distribution might have been more clearly explained.
- 1046 Comprehensive treatment of launch schedule, fuels and fuel synthesis on Mars, orbit transfer, measures of engine efficiency. Adoption of proven technologies seems sensible. Interesting lunar base proposal.
- 1047 A solid submission: Thoughtful discussion, but fuel calculation doesn't feel compelling, lacking an analysis of escape requirements at either side of the journey.
- 1048 Nicely written; includes a clear identification of major phases of consumption, but limited analysis on each of these. An ambitious scheme involving craft assembly and launch from terrestrial orbit; the technological barriers are high, but the scheme is nevertheless commendable.
- 1049 DNS
- 1050 DNS
- 1051 A well-written submission; might have used a more sophisticated orbit transfer strategy and more accurate parameters (masses etc.); some assumptions seem unnecessarily strong (immediate return), and some calculations would have benefitted from additional commentary. The calculated fuel mass seems unrealistically large.
- 1052 Systematic development, nicely presented. This submission is promising in parts, but would have benefitted from additional explanation to thread the calculations together; for instance, the mass and distance calculations do not appear to lead anywhere.
- 1053 Logical development - compelling analysis, clear statement of assumptions. Consideration of the roles of Mars' moons - highly commendable.
- 1054 An outstanding submission. Novel scheme incorporating ISS; comprehensive treatment of all phases of the journey.
- 1055 Not much to fault here: Might have provided a more substantial discussion of the complications of orbit transfer rather than the minimum distance between orbits - which would have demanded lengthier analysis, but the overall impression here is of a focussed, confident team of investigators.

- 1056 Good mathematical basis, food and water requirements taken into account. Organisation and sentence structure could be improved. Key figure not referenced.
- 1057 Good consideration of optimal time and potential of future technology. No calculations showing how final answer was obtained. References not cited at appropriate places within report.
- 1058 Good consideration of optimal time, well written. Calculations not complete.
- 1059 WITHDRAWN
- 1060 Well written with detailed explanations and clearly stated assumptions. Not clear how the binomial theorem enters into the calculations.
- 1061 Split mission is innovative. More detail on the choice of numbers for calculations necessary.
- 1062 DNS
- 1063 Good use of recent rocket science from NASA. Clear explanation of calculations.
- 1064 Staging mission from the moon is innovative. Assuming that 90% of spacecraft mass is fuel begs the question.
- 1065 Well researched and written. Addresses most issues including food, type of fuel, journey time. Major flaw is assumption of 1-way trip.
- 1066 Slingshot approach and assembling spacecraft in orbit is innovative. Fuel required to transport the mission fuel to orbit not included in calculation.
- 1067 Good consideration of different variables, clear explanation of approach and assumptions.
- 1068 Well referenced but there were formatting errors with the referencing, take more care with PDF generation. Nice calculations on the duration of the trip. Good to see all the assumptions listed, although some of the assumptions are suspect.
- 1069 Systematic approach and well written. Separate vessel for return is innovative. Lack of bibliography is a negative.
- 1070 DNS
- 1071 Good consideration of food, water, air requirements. No calculations done.
- 1072 Good discussion of different fuel options. No calculations done.
- 1073 Good discussion of options for generating fuel on Mars for return trip and alternative propulsion technologies. Alternative technologies not well referenced.
- 1074 DNS
- 1075 Good discussion of space elevator concept. References not cited at appropriate places in text. Linear extrapolation of Apollo mission fuel usage not a good estimate.
- 1076 Problem set up clearly, calculations incomplete. References not cited at appropriate places.
- 1077 Detailed calculations of food and water requirements. Very simple model for fuel requirements, assumed one way mission. References not cited at appropriate places.
- 1078 Well written and organised. Good referencing. Calculations not complete due to error in constructing model.
- 1079 Model not well explained, no references.
- 1080 Split mission is innovative. Calculations need to be explained more clearly.

- 1081 Steps clearly explained, but justification for speeds not given and unrealistic assumption of zero velocity in earth orbit. Brownie points for planning a trip to Mars, Pennsylvania.
- 1082 Model clearly explained, systematic approach to calculations. Error in step 1 leads to wrong answers. References not cited at appropriate places.
- 1083 Well written, good referencing. Linear extrapolation of Apollo mission fuel usage not a good estimate.
- 1084 RUNNER UP
- 1085 Nice to see an investigation into two possible propulsion systems. Unfortunately no clear answer and lots of unexplained and unreferenced concepts.
- 1086 Promising beginning but unfortunately unfinished. What was done, was done well. Layout and formatting needed work, to make it easier to read.
- 1087 Brief: Stated that "too much" fuel is required but did no calculations.
- 1088 The material on VASIMR is interesting but the team got too distracted by plasma technology and didn't come up with a clear answer to the problem. Didn't justify statements (eg Mars in 39 days).
- 1089 Nicely structured report with a good approach to the problem. Formatting and layout good. No Return journey. Mass of shuttle was changed - 2040,000 to 104,328kg.
- 1090 Some careful thought into the assumptions and limitations dealt with. No return trip considered: Didn't include mass of fuel with lunar module mass for liftoff. Good to see a clearly stated answer.
- 1091 Nice approach using a combination of an unmanned and manned mission. A bit brief. A number of statements made were not justified/explained thoroughly.
- 1092 Some good thoughts on lowering rocket and cargo weight. Lots of unjustified figures used, eg; food. Didn't included mass of fuel in take off weight. A bit brief.
- 1093 A nice introduction but did not get an answer. Investigated types of fuels. Did no calculations to show existing fuels could/could not be used.
- 1094 WITHDRAWN
- 1095 Nicely laid out and well presented, with good use of graphs to convey information. Very good analysis of two possible approaches. Good idea to use the International Space Station as a base and well thought out VASIMR analysis.
- 1096 A little too brief. Not many actual calculations performed and formatting issues made it hard to read some content.
- 1097 Brief. Lack of calculations. Many figures used were not well referenced. No real answer.
- 1098 A promising start on some areas but unfinished. Lots of figures used and not referenced.
- 1099 Well structured but no return trip (people left on Mars to wait). Final answer too small.
- 1100 WITHDRAWN
- 1101 Nice break down of the problem into stages. Great analysis of mass of equipment required to keep astronauts alive for the trip to Mars. Unfortunately a suicide mission as no return trip and no supplies allowed for staying on Mars.
- 1102 Very nicely formatted. What was done was good, unfortunately unfinished and no references.
- 1103 Some novel ideas and good analysis. Focused on costs a bit. Got a little distracted.
- 1104 Great introduction. Interesting statements regarding political outcry. Layout needs a little work and where is the answer?
- 1105 Well written and nicely formatted. Good step by step breakdown.

- 1106 Well laid out, but then fell a little flat/incomplete. No calculations on food, liftoff from Mars etc.
- 1107 Very well written but got a little side tracked. Did not justify some of the key statements eg. Weight of supplies.
- 1108 Good Layout. Uses technology not yet viable. Is Mass included in equations? Some nice calculations made.
- 1109 Well laid out but unfinished. Got distracted with food lists.
- 1110 Some good thoughts and analysis but brief and let down by poor layout.
- 1111 Some good thoughts on required resources and propulsion although layout needs improving (eg start with an introduction). Assumptions on mass of spacecraft not well justified. Need to be clear on accounting for the mass of fuel during liftoff.