# Post Implementation Testing

## Simulation Testing

Simulation testing will need to include all of the relevant systems that are part of the simulation

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| # | What to test | Approach for Testing | Expected Result | Fail/Pass |
|  | 1 dimensional collision; Correct velocity magnitude when equal masses, and 1 mass is stationary. | Align 2 equal masses on the same plane, have 1 mass stationary, the other with a velocity of 10, collide them without any component of the other dimension. | The mass which has velocity before the collision should have no velocity, the other mass should then have the velocity 10 in the same direction. Total Velocity before should be equal to Total Velocity after. | PASS  Image1  Image2 |
|  | 1 dimensional collision; Correct velocity direction when equal masses and 1 mass is stationary. | Align 2 equal masses on the same plane, have 1 mass stationary, the other with a velocity of 10, collide them without any component of the other dimension. | The velocity of the mass that has been collided with should be equal to 10, in the same direction as the initial velocity. The other mass should have 0 velocity, and therefore no direction. Total Velocity before should be equal to Total Velocity after. | PASS  Image1  Image2 |
|  | 1 dimensional collision; Correct velocity magnitude when unequal masses and 1 mass (Smaller) is stationary. | Align 2 unequal masses on the same plane, have the smaller mass stationary, the other with a velocity of x, collide them without any component of the other dimension. | The smaller mass should gain a percentage of the velocity in the same direction as the larger mass, the larger mass should lose the velocity that the smaller mass gained, thus slowing down. This percentage is calculated by my collision algorithms. | PASS  Image3  Image4 |
|  | 1 dimensional collision; correct velocity magnitude when unequal masses and 1 mass (Larger) is stationary. | Align 2 unequal masses on the same plane, have the larger mass stationary, the other with a velocity of x, collide them without any component of the other dimension. | The larger mass should gain a percentage of the velocity in the same direction as the smaller mass, the smaller mass should lose the velocity that the larger mass gained, thus slowing down as well as changing direction, so the magnitude will be negative. This percentage is calculated by my collision algorithms. | PASS  Image5  Image6 |
|  | 1 dimensional collision; Correct velocity when equal masses, and both masses are moving in same directions. | Align 2 equal masses on the same plane, set their velocities to the same direction, and then set the behind mass’s velocity to a higher value than the other mass. | The faster mass should lose a percentage amount of velocity, and the other mass should gain the lost velocity, both velocities will be in the same direction as they started. Total Velocity before should be equal to Total Velocity after. | PASS  Image7  Image8 |
|  | 1 dimensional collision; Correct velocity when equal masses, and both masses are moving in opposite directions. | Align 2 equal masses on the same plane, set their velocities to the opposite direction, and then set the behind mass’s velocity to a higher value than the other mass. | The masses velocities should perfectly swap. | PASS  Image9  Image10 |
|  | 1 dimensional collision; Correct velocity when unequal masses and both masses are moving in same directions. | Align 2 unequal masses on the same plane, set their velocities to the same direction, and then set the behind mass’s velocity to a higher value than the other mass. | The velocities should redistribute depending on their momentum, which can be calculated using the formula. | PASS  Image11  Image12 |
|  | 1 dimensional collision; Correct velocity when unequal masses and both masses are moving in opposite directions. | Align 2 unequal masses on the same plane, set both of their velocities to a value that are different signs. | The velocities should redistribute depending on their momentum, which can be calculated using the formula. | PASS  Image13  Image14 |
|  | 2 dimensional collision; Correct velocity when equal masses, and 1 mass is stationary. | Place 2 masses of equal mass, make one of the mass’s velocity point towards the other. | The velocities should redistribute depending on their momentum, which can be calculated using the formula. Total Velocity before should be equal to Total Velocity after. | PASS  Image15  Image16 |
|  | 2 dimensional collision; Correct velocity when unequal masses and 1 mass is stationary. | Place 2 masses of unequal mass, make one of the mass’s velocity point towards the other. | The velocities should redistribute depending on their momentum, which can be calculated using the formula. | PASS  Image17  Image18 |
|  | 2 dimensional collision; Correct velocity when equal masses, and both masses are moving. | Place 2 masses of equal mass, make both of the mass’s velocity point towards the other. | The velocities should redistribute depending on their momentum, which can be calculated using the formula. Total Velocity before should be equal to Total Velocity after. | PASS  Image19  Image20 |
|  | 2 dimensional collision; Correct velocity when unequal masses and both masses are moving. | Place 2 masses of unequal mass, make both of the mass’s velocity point towards the other. | The velocities should redistribute depending on their momentum, which can be calculated using the formula. | PASS  Image21  Image22 |
|  | 1 dimensional collision; Conservation of momentum when equal masses, and 1 mass is stationary. | Align 2 equal masses on the same plane, give a mass some Velocity, take reading of Momentum before the collision, take reading of Momentum after the collision | Momentum before will equal Momentum after | PASS  Image1  Image2 |
|  | 1 dimensional collision; Conservation of momentum when unequal masses, and 1 mass is stationary. | Align 2 unequal masses on the same plane, take reading of Momentum before the collision, take reading of Momentum after the collision | Momentum before will equal Momentum after | PASS  Image3  Image4 |
|  | 1 dimensional collision; Conservation of momentum when equal masses, and both masses are moving. | Align 2 equal masses on the same plane, give them both velocity, take reading of Momentum before the collision, take reading of Momentum after the collision | Momentum before will equal Momentum after. | PASS  Image7  Image8 |
|  | 1 dimensional collision; Conservation of momentum when unequal masses, and both masses are moving. | Align 2 unequal masses on the same plane, give them both velocity, take reading of Momentum before the collision, take reading of Momentum after the collision | Momentum before will equal Momentum after. | PASS  Image11  Image12 |
|  | Multiple object collisions. (Very rare to happen, but to be scientifically accurate, it must be included) | Align 3 Masses in an Isosceles Triangle, set one of the mass’ velocity such that it hits the other 2 at the exact same time. | No component of a different plane should be part of the initial mass’s velocity. | FAIL: Reason: Unsolved problem in Maths. |
|  | Top wall collision | Give a mass a velocity that will move them towards the top wall | The mass’ y velocity should reverse | PASS  Image 23  Image 24 |
|  | Left wall collision | Give a mass a velocity that will move them towards the left wall | The mass’ x velocity should reverse | PASS  Image 25  Image 26 |
|  | Right wall collision | Give a mass a velocity that will move them towards the right wall | The mass’ x velocity should reverse | PASS  Image 27  Image 28 |
|  | Bottom wall collision | Give a mass a velocity that will move them towards the bottom wall | The mass’ y velocity should reverse | PASS  Image 29  Image 30 |
|  | Transfer of energy through masses without movement occurring (Newton’s Cradle) | Line up masses so they are touching, give one of the end mass’ a velocity towards the other end. | The mass on the other end should be travelling at the same velocity as what you set the first mass. All other mass’ should be stationary | PASS  Image 31  Image 32 |

## Question Testing

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| # | What to test | Approach for Testing | Expected Result | | Pass/Fail |
| 1 | Question Validity (Are the questions answerable) | Question Validity is a difficult part to test, as there is 2^32 different questions. So there is 3 different ways to approach this problem.  1. Mathematical Proof, If I was to come up with a proof that my algorithm will always output a valid answer, then this would be the best approach, however, since the Question Generation algorithms are difficult to design, I will have to leave this until I complete the question generator. | No incorrect answers | Pass  When a question is generated, the algorithm picks a point where the particles will collide, it then sets each velocity to be a scaled down version of the distance to that point, how much the algorithm scales it down by is the amount of time it will take to get there, since the scale factor for each particles velocity is the same, they will reach that point at the same time, therefore guaranteeing a collision. | |
| 2 | User Input | For the answer 5/3, enter the following inputs:  5/3  10/6  1.66 | Different forms of the same answers are accepted. | | FAIL: Reason: In A Level Physics you are **always** required to answer in sig figs, therefore as a teaching aid it would be wrong to teach students bad habits.  Sig Figs PASS. |
| 3 | Question Answers | Manually complete 20 Questions, compare answers, if any are wrong then the code needs to be re-evaluated through White-Box testing. | No incorrect answers | |  |
| 4 | Question type distribution | Give a type to each style of question, generate 10,000 questions, for each time a question is generated, increment the respective type by 1, then work out percentages. | Nothing too bias. (>40%) | | PASS  All types have equal chance. |
| 5 | Question scenario viewer | Load the simulation with a question seed, close the program, and the load it again with the same seed. | The scenarios and questions generated should be exactly the same | | PASS |

## Database Testing

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| # | What to test | Approach for Testing | Expected Result | Pass/Fail |
| 1 | Saving Data | Answer a question | Result appears in Database | PASS  Image 33  Image 34  Image 35 |
| 2 | Retrieving Data | Login as teacher | Results appears in Results Viewer | PASS  Image 36 |

## Interface Testing

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| # | What to test | Approach for Testing | Expected Result | Pass/Fail |
| 1 | Play Button | Click play button | Scenario plays/pauses | PASS |
| 2 | Interface input selection | Click on an interface | Interface receives click input, | PASS |
| 3 | Text input box | Type characters in the input box, use a variety such as ‘whitespace’ characters, numbers, letters and space. Test each input as they have different validation methods. | No Whitespace (Except space in Results Viewer) Student ID must match S00000 or 00000, where 0 can be any digit No special characters in password/username | PASS |
| 4 | Text box event update | Press the enter key to either login or answer a question | Logs in or Answers question through keyboard event. (Equivalent to pressing the button) | PASS |
| 5 | Text box always update | Search for a user in the results viewer, it should always update. | Table is searched, updated and sorted whilst typing. | PASS  Image 37  Image 38 |
| 6 | Radio buttons | Click on one of the particles values on the information screen at the bottom. | Value should toggle visibility on and off. | PASS |
| 7 | Play/Pause image switching | Click on Play/Pause | The image changes to the other one. | PASS |
| 8 | Test that the view options work during a question | Open a question and simulate until after the collision, check the values. | All values should be hidden, as you have to work them out from the previous values before the collision. | PASS  Image 42  Image 43 |
| 9 | Test that editing each balls value works | Enter in a value that affects other values, such as Velocity. | All affected values should be updated. | PASS  Image 44  Image 45 |
| 10 | Test the left click drag | Left click and hold on a mass, move cursor to move the mass | The mass moves with the cursor | PASS |
| 11 | Test the right click, change velocity works | Right click and hold on a mass, move cursor to edit the mass’ velocity | The velocity moves with the cursor in the negative direction | PASS |
| 12 | Test that the middle mouse wheel, change size works | Hover over a mass, use mouse wheel | Size of mass will change, with a minimum and maximum size | PASS |
| 13 | Test that the middle mouse button removes the velocity | Press middle mouse button over a mass with velocity | Mass loses all velocity | PASS |
| 14 | Test the add mass button | Click the add mass button | A new mass gets added | PASS |
| 15 | Test the delete mass button | Click on a delete mass button | The respective mass gets deleted | PASS |
| 16 | Test the step button | Click on the step button | Program will pause when the next collision happens | PASS  Image 40  Image 41 |
| 17 | Test the reset button, no question loaded | Click on the reset button | All masses will be removed | PASS |
| 18 | Test the reset button, question loaded | Click on the reset button with a question loaded | Scenario will be set to its default question state | PASS |
| 19 | Login button | Click on the login button | Doesn’t log in. | PASS |
| 20 | Login button | Fill out StudentID with s30256 | Logs in correctly. Displays logged in message. | PASS  Image 51 |
| 21 | Login button | Fill out StudentID with f31134 | Shouldn’t be able to type it in. | PASS |
| 22 | Login button | Fill out teacher login details correctly | Logs in correctly. Displays logged in message. | PASS  Image 50 |
| 23 | Login button | Fill out teacher login details incorrectly (username wrong, password wrong, or both) | Error: Invalid username and/or password | PASS  Image 49 |
| 24 | Login button | Try to login when the SQL server is down/not able to be connected to. | Unable to connected error message | PASS  Image 46 |
| 25 | New question button | Click on the new question button | Generates a new question | PASS  Image 39 |
| 26 | Mark question button | Answer the question incorrectly, click on the mark question button, and then answer is correctly. | Validates your first answer and uploads it, when you correct the answer it will tell you if it’s correct or not. | PASS  Image 47  Image 48 |
| 27 | Search results text field | No validation, enter either studentID, or first, or second name. | Shows students that match what you entered | PASS  Image 37  Image 38 |
| 28 | Test the search results | Enter Ryan | User “Ryan Ramsden” should be in the list | PASS  Image 37  Image 38 |
| 29 | Results Section | Answer questions on different computer. | New results can be accessed through the Results Section | PASS |
| 30 | Open scenario button | Click on open scenario button | Opens scenario | PASS |
| 31 | Question scroll bar | Drag scroll bar vertically | Browses through answered questions | PASS |
| 32 | Close dialog box button | Click on close dialog button | Closes respective dialog | PASS |