**Stage 2 Physics**

**Assessment Type 2: Skills and Applications Task 1**

**Name:**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Purpose**

This assessment provides you with the opportunity to demonstrate your ability to represent, analyse, and interpret investigations in physics through the use of technology and numeracy skills, communicate knowledge and understanding of the concepts and information of physics using the appropriate literacy skills of physics and demonstrate and apply knowledge and understanding of physics to a range of applications and problems relating to motion.

**Description of assessment**

You will use a computer program to analysis a range of videos of motion and answer a series of questions from subtopics 1.1 to 1.3. You will complete the assignment in a word processing program and submit your answers electronically at the end of the lesson. You should have the program “Tracker” installed on the computer which you will use to do this Skills and Application Task. You should be familiar with analysing motion of objects in a video with this program prior to beginning this task.

You need to:

* Communicate your knowledge and understanding clearly and concisely
* Use physics terms correctly
* Present information in an organised and logical sequence
* Include only information that is relevant to the question
* Use clearly labelled diagrams that are related to your answer
* Show all steps and reasoning in your answer
* Give answers with appropriate units, directions and significant figures

You may use the formula sheet provided to select appropriate formulae. In this assessment, vectors are shown with bold type.

**Assessment conditions**

You will have 90 minutes to complete this Skills and Application Task under the supervision of a teacher. You will only access the Tracker program and word processing software. You will have 5 minutes before the start of the task to read through the task sheet and load the required videos. These video are found on the school’s server at ……

A calculator may be used.

**Performance Standards**

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|  |  | **A** | **B** | **C** | **D** | **E** |
| **Investigation, Analysis and Evaluation** | IAE2 | Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. | Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. | Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. | Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. | Attempts to record and represent some data, with limited accuracy or effectiveness. |
| IAE3 | Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. | Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. | Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. | Describes data and undertakes some basic interpretation to formulate a basic conclusion. | Attempts to describe results and/or interpret data to formulate a basic conclusion. |
| **Knowledge and Application** | KA1 | Demonstrates a deep and broad knowledge and understanding of a range of physics concepts. | Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts. | Demonstrates knowledge and understanding of a general range of physics concepts. | Demonstrates some basic knowledge and partial understanding of physics concepts. | Demonstrates limited recognition and awareness of physics concepts. |
| KA2 | Applies physics concepts highly effectively in new and familiar contexts. | Applies physics concepts mostly effectively in new and familiar contexts. | Applies physics concepts generally effectively in new or familiar contexts. | Applies some physics concepts in familiar contexts. | Attempts to apply physics concepts in familiar contexts. |
| KA4 | Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations. | Communicates knowledge and understanding of physics mostly coherently, with effective use of appropriate terms, conventions, and representations. | Communicates knowledge and understanding of physics generally effectively, using some appropriate terms, conventions, and representations. | Communicates basic physics information, using some appropriate terms, conventions, and/or representations. | Attempts to communicate information about physics. |

**Video One**

Open the video “basketball” within the Tracker program. Track the motion of the basketball from frame 7 to frame 43. Put the coordinate axis at the location of the ball in frame 7. Use the 2.0-metre-long blue stick (pictured below) shown in the video where the floor meets the wall to calibrate the distance. The video has 30 frames every second.



**Question 1**

* 1. Take a screenshot capture of the track of the basketball. Show that the horizontal component of the velocity of the basketball is constant (after it has left the basketball player’s hands). Include the screenshot in your answer below.

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| (3 marks) |

* 1. Explain, using your knowledge of projectile motion, why the basketball has constant horizontal velocity.

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| (2 marks) |

* 1. State the time of flight of the projectile during these frames

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| (2 marks) |

* 1. State the average horizontal velocity of the basketball using the “vx” data in Tracker.

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| (1 marks) |

* 1. Calculate the range of the basketball between frames 7 and 43 using parts c) and d) only.

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| (2 marks) |

**Question 2**

Predict, giving a logical explanation, the effect on the maximum range and time of flight if the basketball player was to release the ball while jumping higher in the video.

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| (4 marks) |

**Question 3**

* 1. By rotating the coordinate axis in Tracker, find, and state below, the approximate launch angle of the basketball.

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| (1 marks) |

* 1. Using parts, a) iv) and vi) only, calculate the initial speed of the basketball.

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| (1 marks) |

* 1. Calculate the initial vertical component of the velocity by using appropriate equations learnt in class and the answers you have found so far.

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| (2 marks) |

* 1. Calculate the maximum height of the basketball. (use $a=-9.8 ms^{-2}$)

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| * + 1. marks)
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**Question 4**

The basketball is replaced by a tennis ball, and is launched at the same angle and speed. Choose one feature of the tennis ball and explain how it will affect the maximum height obtained.

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| (4 marks) |

**Video Two**

Open the video “video\_student\_riding\_rocket” within the Tracker program. Track the motion of the student from frame 15 to 75, taking 5 frames at a time. Place the coordinate axis at an appropriate mark. Use the distance indicated in the video to calibrate the distance. The video has 30 frames every second. Assume constant acceleration throughout part two. Mass of student and cart is 105 kg.

**Question 5**

* 1. Using the “vx” column in Tracker, state the final velocity of the student and cart.

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| (1 marks) |

* 1. Calculate, using an appropriate formula, the change momentum of the student and cart.

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| (2 marks) |

* 1. State the total change in momentum of all the CO2 emitted.

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| (1 marks) |

* 1. Using the law of conservation of momentum, explain how a spacecraft maybe accelerated by the emission of a gas such as CO2.

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| (3 marks) |
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**Video Three**

Open the video “2ballcoll1” within the Tracker program. Track the motion of both billiard balls from frame 6 to 23, taking 2 frames at a time. Use two tracks for each ball, one before the collision and one after (4 tracks in total). Assume both balls are of equal mass.

**Question 6**

1. Derive a formula expressing the conservation of momentum for two billiard balls in a collision.

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| (3 marks) |

1. Show that the momentum is approximately conserved in the collision between the two billiard balls. Include a screenshot capture of the billiard balls and vectors drawn in this program.

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|  (5 marks) |

**Video Four**

Open the video “rotating\_wheel\_mov” within the Tracker program. Track the motion of the blue circle from frame 286 to 296, taking two frames at a time.

**Question 7**

1. State the mean radius of the Blue circle.

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| (1 marks) |

1. By playing the video so that the blue circle makes one full rotation, find its Period.

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| (1 marks) |

1. Calculate the linear velocity of the blue circle, using an appropriate formula.

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| (2 marks) |

1. By using a screenshot capture of the track (from frame 286 to 296), show that the change in velocity, hence acceleration, is towards the centre of the axis of rotation.

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| (4 marks) |

**Video Five**

Open the video “a16v.1213311” within the Tracker program. From approximately frames 5684 to 5740, you can see the astronaut on the moon throwing an object, which reflects light at different points on its path. The height of the rectangular part of his back pack is 70 cm as picture aside.

**Question 8**

1. By using the change in the height of the object and an appropriate projectile motion formula, approximate the acceleration due to gravity on the moon.

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| (5 marks) |

1. Using $g\_{moon}=\frac{F}{m}$, calculate the acceleration due to gravity at the moon’s surface. The mass of the moon is $7.35×10^{22} kg$.

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| (1 marks) |

1. State and explain one reason for the difference between the two values for the acceleration of gravity at the moon’s surface.

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| (3 marks) |

**Video Six**

Open the video “issatv19mar08m-b” within the Tracker program. This is a video of the European Space Agency's Jules Verne cargo carrier in front of the International Space Station (ISS) on March the 19th, 2008, seen from a city in Germany. The bright object that moves from the top right to bottom left from frame 302 is the ISS. The camera is taking 270 frames per second and the standard length of the measuring stick, that pops up when you insert one, needs to be changed to 139.4 m. Track the ISS from frames 313 to 321 taking 4 frames at a time. The radius of the Earth is $6.37×10^{6}$ m and has mass of $5.97×10^{24}$ kg.

**Question 9**

* 1. Use the three steps created to calculate the velocity of the ISS.

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| (2 marks) |

* 1. ISS is in a Near-Earth-circular orbit. Estimate the altitude (in kilometres) of ISS, using an appropriate formula.

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| (4 marks) |

* 1. Use Kepler’s 3rd law to estimate how long ISS takes to complete one full orbit of the Earth

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| (3 marks) |

* 1. State and explain one advantage of ISS in a Near-Earth orbit.

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| (3 marks) |

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| **Notes to teacher:*** Before commencing this SAT, students should be familiar with, and have had practice in, analysing videos using the “Tracker” Video Analysis program. The program can be downloaded at <http://physlets.org/tracker/>. A good place for students to start is the following tutorial at <https://www.youtube.com/watch?v=Dn0Zz7rtkZw>.
* Students computer will also need Java 1.6 or higher installed.
* Students will need to be competent with writing equations into a word processing program of choice. (alternatively, students can submit part of this SAT electronically and part in hand written form)
* It is advisable to encourage students to load all videos into the Tracker program during the reading time.
* If possible, limit access to only the Tracker and word processing programs. Alternatively, if this is not possible at your school, constant observation of what students are accessing is essential, just as it is for a hand written SAT.
* Marks are less than would normally be allocated in 90 minutes, this extra time is for the extra time required to manipulating the software.
* The access to the following videos is needed: (It is suggested to share them on the local server or through the Learning Management System at your school)
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| **Part** | **Name** | **Website** |
| **1** | Basketball shot | <http://physics.highpoint.edu/~atitus/videos/> |
| **2** | video\_student\_riding\_rocket | <http://serc.carleton.edu/dmvideos/videos/student_riding.html>  |
| **3** | 2ballcoll1 | <http://physics.doane.edu/physicsvideolibrary/movies/2ballcoll1.mov>  |
| **4** | rotating\_wheel\_mov | <http://serc.carleton.edu/dmvideos/videos/rotating_disk.html>  |
| **5** | **Video Clip:** [121:33:11](https://www.hq.nasa.gov/alsj/a16/a16.deepcore.html#1213311)   | <http://www.hq.nasa.gov/alsj/a16/a16v.1213311.mpg>  |
| **6** | [issatv19mar08m-b.mpeg](http://www.spaceweather.com/swpod2008/20mar08/issatv19mar08m-b.mpg?PHPSESSID=sotr4go74qbsjiqojf6eda00e3&PHPSESSID=0dlctfcdhq47ii6fsa1enu5a62) (Needs to be converted to .mov file) | <http://www.spaceweather.com/swpod2008/20mar08/issatv19mar08m-b.mpg?PHPSESSID=sotr4go74qbsjiqojf6eda00e3&PHPSESSID=0dlctfcdhq47ii6fsa1enu5a62> Original video from: <http://www.theskyinmotion.com/issatv19mar08v.html>  |