**Test 4 Suggested Answers**

**Short answer**

**Question 1 a)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 20 = | **1** |
| to = 20 x = 11.45 minutes | **1** |
| Time on clock = 6:41:27 am | **1** |

**b)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 6:41:27 am | **1** |
| All movement is relative in each inertial frame | **1** |

**Question 2 a)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 0.99c | **1** |

**b)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
|  | **1 – 2** |
| 0.999c | **1** |

**Question 3**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Photoelectric effect – particle  Young’s double slit – wave | **1** |
| Light collides with the metal knocking electrons from the atom in ionisation | **1** |
| Light as a wave is diffracted through each slit | **1** |
| The wavefront interfere (construction/distruction) forming an interference pattern | **1** |

Question 4 a)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| s= vt = 3x108 x 2.2x10-6 | **1** |
| 660m | **1** |

b)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| As the speed increased the time dilation increases (may discuss either muon or Earth frame of reference) | **1** |
| The muons last longer as they travel so fast | **1** |

**Extended Answer**

**Question 1 a)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 1 s | **1** |

**b)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| t = | **1** |
| 1.90 s |  |

**c)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| The observer in the spacecraft is not moving relative to the clock so is measuring a proper time | **1** |
| There is a relative motion between the observer on Earth and the spacecraft | **1** |
| To maintain the ratio of distance to time to keep the speed of light constant, there must be a dilation in time for the observer in the Earth’s reference frame | **1** |

**d)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| l = 119 x | **1** |
| 62.7 m |  |

**e)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| No change | **1** |
| Length contraction only occurs in the direction of motion | **1** |

**f)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
|  | **1** |
| 2.84x108 m s-1 | **1** |

Question 2 **a)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| = *h*/*p*   = *h*/mv  6.63x10-34 / (9.11x10-3 x 2.00x106) | **1** |
| m | **1** |

**b)**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Electrons act as a wave | **1** |
| Orbitals are standing waves around the nucleus based on factors of wavelengths | **1** |
| Energy levels of orbitals are discrete quanta as a result | **1** |

**c)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| As electrons drop to lower energy levels | **1** |
| they release the amount of energy associated with the loss of energy | **1** |

**d)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 18.6 eV | **1** |

**e) i)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 9.92 x 10‑19J = 6.2 eV, this corresponds to transition from  2 to 1 | **1** |

**(ii)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 4 🡪 3 | **1** |

**f)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Energy of e’s = 2.1 x 10‑19 / 1.6 x 10-19 = 13.1eV | **1** |
| 13.1 – 0 = 13.1eV (No transition) | **1** |
| 13.1 – 6.2 = 6.9eV (Level 1 to 2) | **1** |

**Question 3**

**a)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Line absorption spectrum | **1** |

**b)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Elements in the Sun’s atmosphere absorb specific frequencies | **1** |
| Causing electrons to jump to higher energies – thus specific frequencies are removed from the spectrum | **1** |

**c)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| A, C | **1 - 2** |

**Comprehension/Data analysis**

**a)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  | **Axis**  **Labels**  **Points**  **LOBF**  **(4)** |

**b)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Uses line at x- intercept | **1** |
| 0.578 x1015 Hz  (range 0.55 – 0.59) | **1** |

**c)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| =c/f | **1** |
| 3x108 / 0.578x1015 | **1** |
| 5.19x10-7 m (range 508nm – 545nm) | **1** |
| Green | **1** |

**d)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Red light does not have sufficient energy to cause emission of electrons | **1** |
| Energy is not built up over time (intensity) so the energy of the light photon must be higher than the work function | **1** |

**e)**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Sodium | **1** |