**Standard model and particle physics Solutions**

**Section 1**

**Question 1**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Recognise anti particles are opposite charge | **1** |
| +⅔+ -⅔+ -⅓+ -⅔  -1e | **1** |

**Question 2**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| How much the lines are shifted is related to the stars velocity | **1** |
| Greater the redshift the greater the velocity of the object | **1** |

**Question 3**

a

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Red shift | **1** |

**b**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Star is moving away, wavelengths are lengthened | **1** |
| All spectral lines are displaced towards the red end of the spectrum | **1** |
| Greater the recession the greater the red shift | **1** |

**c**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| How fast the star is moving | **1** |

**Question 4**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Interactions – Gravity; Strong | **1 - 2** |
| Field Particles – W and Z bosons; photons | **1 - 2** |

**Question 5**

**a**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 4TeV= 4x1012eV  =4x1012 x 1.6x10-19  =6.4x10-7J | **1** |

b

|  |  |
| --- | --- |
| **Description** | **Mark** |
| m= 3x10-6 kg | **1** |
| 0.653 m s-1 | **1** |

**Section 2**

**Question 1**

a

|  |  |
| --- | --- |
| **Description** | **Mark** |
| X and uniform | **1** |

**b**

|  |  |
| --- | --- |
| **Description** | **Mark** |
|  | **1** |
| Shows correct rearrangement and calculations | **1** |

**c**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| v= 0.998 x 3x108 = 2.994x108 m s-1 | **1** |
| B= = | **1** |
| 4.90 x 10-3 | **1** |
| 3 sig fig | **1** |
| T (unit) | **1** |

**d**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Bends up instead of down and/or unchanged radius | **1** |
| Radius decreases | **1** |
| Radius increases | **1** |
| Radius decreases | **1** |

**e**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Increasing the speed of the particle increases its mass | **1** |
| The more massive a particle the larger the radius | **1** |

**f**

|  |  |
| --- | --- |
| **Description** | **Mark** |
|  | **1** |
|  | **1** |
| 1.29x10-12 J | **1** |

**Question 2**

**a**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Spin 1 ½ | **1** |
| Charge +1e | **1** |
| Baryon number +1 | **1** |

**b**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 1. BN for n = +1 BN for p = +1 (same both sides) | **1** |
| 1. LN for e- is +1 but is 0 on the left so not conserved | **1** |
| 1. Electron antineutrino | **1** |

**c**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Identifies and describes one type of gauge boson | **1 – 2** |
| Examples   * Gluon: provides strong force between quarks * Photon: provides electrostatic force between protons * Higgs boson: provides mass to particles * W,Z boson: provides weak force (beta decay) |  |

**Section 3**

**a**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Moving away | **1** |

**b**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| The wavelength of the calcium line in the spectrum from NGC 1357 has increased | 1 |
| This is a characteristic of a source moving away from an observer  (Earth 396.85 nm, NGC 1357 399.72 nm) | 1 |
| Diagram to show changes in wavelengths towards and away from observer. | 1 - 2 |

**c**

|  |  |
| --- | --- |
| **Description** | **Mark** |
|  | 1 |
| v = 2.17 x 106 m s-1 | 1 |

**d**

|  |  |
| --- | --- |
| **Description** | **Mark** |
|  | 1 |
| 7.791 x 10-11 m = 0.0791 nm | 1 |