**TASK 5 Evaluation and Analysis Answers**

**Question 1 (19 marks)**

(a) Explain why black bodies are called “black bodies”. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| They absorb all incident radiation and therefore appear totally black. | **0-2** |
| **Total** | **2** |

(b) In terms of photon energy, why do hotter stars emit shorter wavelength light? (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Hotter stars will emit more energetic photons  E = hf = hc/λ  i.e. The energy of emitted photons is inversely proportional to wavelength and shorter wavelength photons are more energetic. | **0-2** |
| **Total** | **2** |

(c) Explain why all three stars in the figure have the same maximum intensity. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The y axis shows the normalised intensity. i.e. all intensity values for a particualr star have been divided by the maximum intensity for that star. Max = 1 | **0-2** |
| **Total** | **2** |

(d) Using information from the article and data from the Formula and Data booklet, show that the luminosity of the Sun is approximately 3.8 x 1026 W m-2. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| L = σ4πR2 T4 | **1** |
| = (5.67 × 10 –8)(4π)(6.96 x 108)2(5800)4 | **0-2** |
| = 3.90 x 1026 W m-2 | **1** |
| **Total** | **4** |

(e) Some data for the variable star Betelgeuse are given below.

Average apparent brightness = 1.6 x 10-7 Wm-2

Radius = 79 solar radii

Earth – Betelgeuse distance = 1.38 x 10-4 Mpc

(i) Calculate the distance between the Earth and Betelgeuse in metres. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 1 Mpc = 3.09 x 1019 km (from data sheet)  D = 1.38 x 10-4 x 3.09 x 1019 x 103 | **1** |
| = 4.26 x 1018 m | **1** |
| **Total** | **2** |

(ii) Calculate the luminosity of Betelgeuse. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  | **0-2** |
| L = 3.65 x 1031 W m-2 | **1** |
| **Total** | **3** |

(iii) Calculate the surface temperature of Betelgeuse. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| L = σ4πR2 T4  3.65 x 1031 = (5.67 × 10 –8)(4π)(79 x 6.96 x 108)2(T)4 | **0-2** |
| T = 11,400 K | **1** |
| **Total** | **3** |

**Question 2 (18 marks)**

1. Rutherford’s planetary model of the atom was considered flawed. Explain why.

(2)

The electron charges are accelerating in circular orbits ✓, so according to Heinrich Hertz accelerating charge radiates energy, which would lead to energy of electrons decreasing.✓ This is not the case. ✓



1. What type of experimental data could have verified Bohr’s energy level values for the hydrogen atom?

(2)

Line emission spectrum from hydrogen ✓

Using E = hf to confirm energy level differences from measured frequencies. ✓

Or similar valid explanation



1. The formula can be simplified to,

Calculate the numerical value of X, showing all working and stating your answer in scientific notation.

(3)

**** ✓ ✓

X = 2.17 × 10-18 J 

1. In terms of energy in electron volts the formula in part c) may also be written

Use this formula to calculate the energy level values for hydrogen for n = 1, 2, 3 and 4 (2)

|  |  |
| --- | --- |
| Energy Level Number | Energy level value (eV) |
| 4 | -0.85 |
| 3 | -1.51 |
| 2 | -3.40 |
| 1 | -13.6 |

1. How did the work of Louis de Broglie link back to the predictions of Niels Bohr?

(2)

It confirmed the circumferences of Bohr energy levels ✓

Circumference is based on radius which Bohr predicted. ✓



1. Use the *De Broglie equation for wavelength of a particle* to calculate the wavelength of a cricket ball of mass 250 g bowled at 20 m s-1 and explain why it is hard to observe wave motion of a cricket ball along its projectile path.

(3)

 

λ = 1.33 × 10-34 m ✓

Very small so difficult to measure ✓

1. How is a De Broglie electron orbit similar to a guitar string that has been plucked?

(2)

Principle of standing waves, a guitar string vibrates as a standing wave, electron orbits seem to reinforce like standing waves. ✓ ✓

Or words to that effect.

1. What is the fundamental difference between a conventional microscope and a tunnelling electron microscope?

(2)

Conventional microscope uses light behaving as a wave ✓

Electron microscope uses electrons behaving like waves ✓