How the universe works – Answer Key

Star dust is the building blocks of life. Every **atom** in your body was produced inside the fiery core of the sun. All **life** begins with stars. In our galaxy there are over **100 billion** stars and in the universe there are over **100 billion** galaxies. There are more **stars** than there are grains of **sand** on earth. Every star can **create** the basic matter for **everything** in the universe, including us. Stars are balls of super-heated **gas**. You could fit a **million** earths inside the sun. Our sun is over a **million** km in diameter. The largest star ever discovered is a **billion** times larger than our sun. Each star is a **one of a kind** but they all start off in the same way, as clouds of dust and gas called **nebulas**. Each nebula is a star **nursery**, where millions of new stars are being **born**. All you need to make a star is **hydrogen**, **gravity** and **time**. Gravity brings matter **together**. When you squeeze things into smaller spaces they **heat** up. The secret of the stars is Einstein's equations, **$E=MC^2$**. Fusion is the **smashing** of atoms, the same force that **powers** stars. From Einstein's theories we learned how to release the **energy** inside an atom. Hydrogen atoms naturally **repel** each other. To smash hydrogen atoms together you need to heat them to more than **166 million** degrees. At these temperatures, the hydrogen atoms are moving so fast, they can't **avoid** smashing into each other. They hydrogen atoms are travelling more than **1000km per second**. The hydrogen atoms smash into each other and fuse, creating a new element, **helium** and a small amount of pure **energy**. With our current technology, we can only create fusion for a fraction of a second. Inside a star, fusion continues for billions of years because of its size. The engine that drives a star is **gravity**. You need large amounts of gravity to **compress** the star to create large amounts of heat, to ignite nuclear fusion. Fusion at the core of the sun generates the explosive force of a **billion** nuclear bombs, every second. A star is a gigantic hydrogen **bomb**. A star doesn't explode because **gravity** compresses the outer layer. Gravity and fusion are in an epic **battle**. Gravity wants to **crush** a star and the energy released from the fusion process wants to **blow** the star apart. That **tension** creates the star. Light travels at 1,080,000,000km/h. A beam of light could travel around the earth **7** times in **1** second. Nothing in the universe moves faster

than a **beam of light**. When the sun fuses **hydrogen** into **helium** in its core, it produces a photon (particle) of **light**. It takes a photon **1000s** of years to get from the core of the sun, to the surface. Once it hits the surface, it only takes **8 minutes** to get to earth. Photons are the source of **light** and **heat**. They also cause solar wind, which can damage satellites and space ships. A white dwarf is a **million** times denser than the earth. After a star dies, all that is left, is a white dwarf. From the destruction of a star, comes **life**. The death of massive stars creates the **building** blocks of the universe. The core of a large star is like a **factory**, manufacturing heavier and heavier **elements**. This is what leads a star to its destruction. To a star, **iron** is poison because it **absorbs** energy. From the moment a massive star creates iron, it only has **seconds** to live. In the battle between fusion and gravity, **gravity** always wins. The most violent event in the universe is a **super nova**, the explosion of a star. White dwarfs are formed from the collapse of a **low** mass star. Neutron stars are formed in the catastrophic collapse of a **massive** star.

The corpse of a supernova explosion is a **neutron** star. It is about 30km across and unbelievably heavy. A sugar cubed size of a neutron star would weigh as much as all the cars in the United States. The dying star doesn't just leave the corpse of a neutron star, it blasts the new **elements** far out into space. These clouds contain the building blocks of the universe. Everything we know and love is built from this star dust. Only a supernova has enough energy to fuse the elements **essential** to life. Without supernovae, there is **no life**. When massive stars die, they scatter the **universe** with star dust. Star dust is full of elements such as **hydrogen**, **carbon**, **oxygen**, silicon and iron. The raw materials to build new **stars**, **solar systems** , **planets** and **us**.