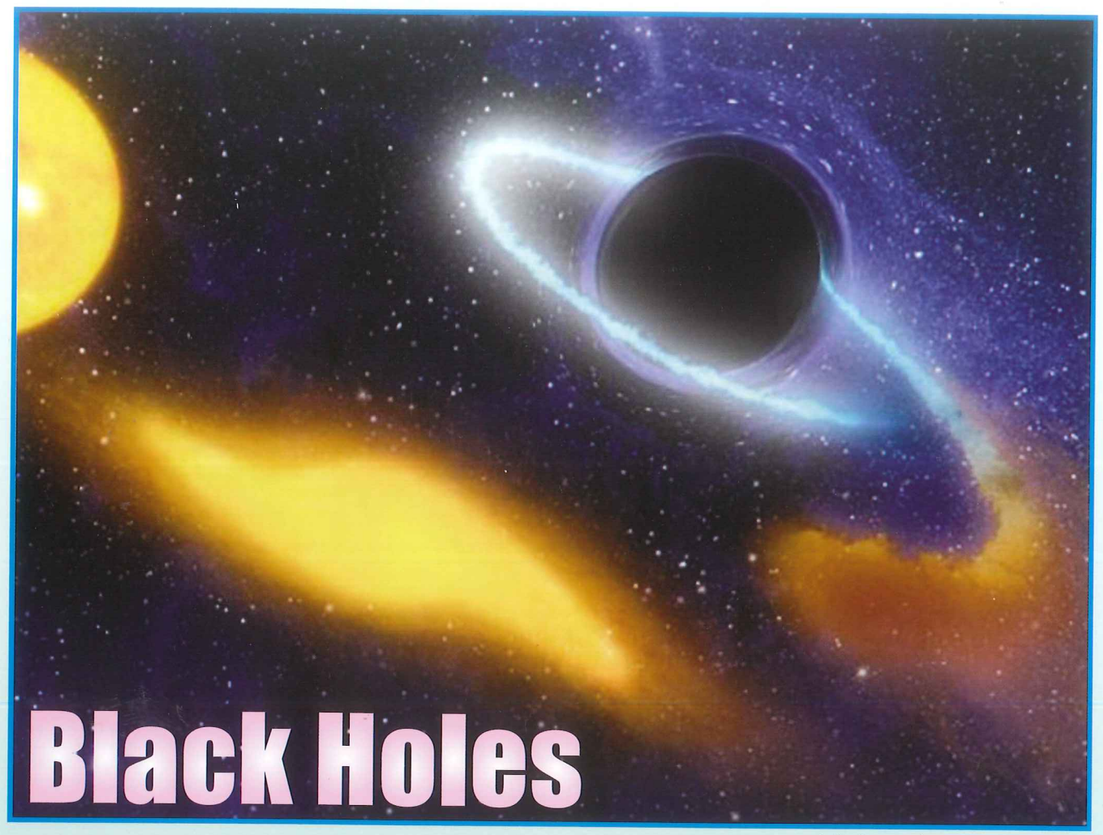

Black Holes

Artist impression courtesy of NASA

1 A black hole isn't just another name for a messy bedroom! It's a dense region in space with such a large mass that anything close to it is sucked in by its gravitational pull. A black hole is formed when a giant star dies. The core of the star collapses under its own gravity until it becomes so dense that not even light can escape its pull. This is why they appear to be black.

2 How does something become denser as it collapses in on itself? Imagine you've been to a carnival and bought a stick of fairy floss. Now crush that fairy floss as small as you can. You still have the same amount of fairy floss, the same mass, but now it takes up a much smaller space. It has become denser than when you first bought it.

3 Not all stars become black holes; the Sun, for example, is simply too small in mass to ever become dense enough. When the sun eventually comes to the end of its life, it will firstly become a red giant that cools and expands. The core will collapse and reignite. Eventually, it will cool and expand again, its outer layers bursting away. All that will be left behind is a white dwarf star. But don't worry about that just yet!

4 Are you wondering how you can see a black hole when everything around it is black? Well, one way is to find something with a huge mass that is small in size. Imagine the size of the sun; with a radius of 700,000 km, it's huge. A black hole with the same mass as the sun would have a radius of just 3 km. That's really dense and everything near it would be moving really fast!

5 As a star is dragged into a black hole, it spins and swirls, becoming very hot. Some of the star's mass can be converted to energy and be released as jets of particles before the *event horizon* — the point of the black hole where its gravitational pull is so strong that nothing can escape it — is reached. These jets, along with the heat, can be seen as X-ray radiation.

Once something has entered the event horizon, there's no way of getting out. Before that point of no return is reached, it is still possible to escape.

6 Wondering how that can happen? Imagine yourself strapped inside a rocket as mission control counts down. 5, 4, 3, 2, 1, lift off! You surge from the ground. The speed you need to travel to escape Earth's gravitational pull is known as the *escape velocity*. Everything that has gravity, like moons, stars and planets, has an escape velocity. Earth's ground escape velocity is 11.2 km per second.

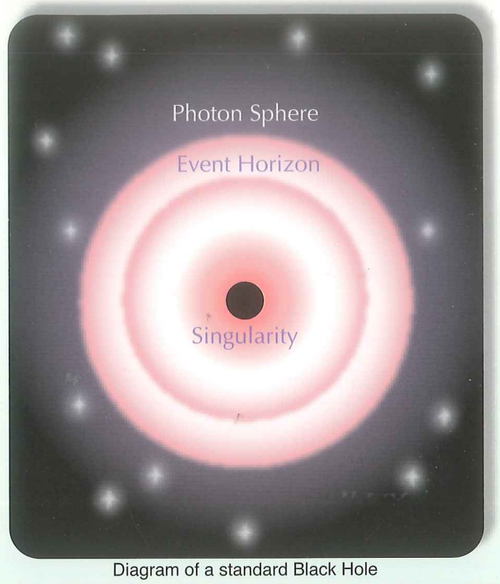

Diagram of a standard Black Hole

7 The escape velocity at the event horizon in a black hole is more than the speed of light. In a vacuum (for example, space), light has a constant speed of almost 300,000 km per second. We do not know of anything that can travel faster than this speed, so if light can't escape a black hole, nothing can! The further you move away from the event horizon, the lower the escape velocity — and the greater the chance of your survival.

8 Think you could get away? You'd better hope so, because if you don't, you'll be sucked into the centre of the black hole. The centre is known as the *singularity*. The gravitational pull of a black hole is strongest at its singularity. As you move away from the centre, the gravity becomes weaker.

So, imagine you jumped in feet first. Your feet would be closer to the centre than your head and gravity would pull them harder. You'd stretch out like a piece of chewing gum. This is called *spaghettification*. Great if you want to be taller, but you would eventually snap!

9 Before you get as far as the event horizon though, some really weird stuff starts to happen. There's a point around a black hole where gravity is so intense that it actually bends space! This is the *photon sphere*.

Light travelling at this point actually goes around in a circle.

This effect is known as an *Einstein ring*.

If you want to check out the job the hairdresser did on you, take a trip to the photon sphere. Light coming from the back of your head will travel in a circle and you'll actually be able to see it in front of your face.

10 Scientists believe there is a gigantic black hole at the centre of our galaxy, the Milky Way. Hopefully it won't get too big for its boots — otherwise we might all become a bowl of galactic spaghetti!

Questions

1 What type of stars can become black holes?
- a any stars
- b giant stars
- c tiny stars

2 What is the speed of light in a vacuum?
- a almost 300,000 km per second
- b almost 3,000,000 km per second
- c almost 700,000 km per second

3 Everything that has gravity has
- a an event horizon.
- b an escape velocity.
- c a singularity.

4 *Spaghettification* is
- a moving faster than the speed of light.
- b the collapse of a dying star.
- c being stretched really thin.

5 In what order will you encounter these parts of a black hole?
- a photon sphere, event horizon, singularity
- b event horizon, photon sphere, singularity
- c photon sphere, singularity, Einstein ring

6 Why do you think the centre of a black hole is called a *singularity*?
- a There is only one of them in existence.
- b It is the single thing about a black hole that scientists can't explain.
- c Everything sucked into a black hole becomes part of this single point.

Vocabulary

Find words in the text that match the meanings below. The word is in the section shown in brackets.

7 A force which attracts objects towards it (1)
8 Transformed or changed into something (5)
9 The speed of movement (6)
10 An empty space (7)
11 Very strong and powerful (9)

Alphabetical Order

*The following words appear in the text. When placed in alphabetical order, which one would be **first**?*

12 entered, escape, enough, everything
13 gravity, ground, greater, great
14 fast, further, fairy, first
15 speed, spin, space, sphere

Back To The Text...

16 What would be a good sub-heading for section 8?
- a The Event Horizon
- b The Singularity

17 The purpose of this text is
a to persuade. b to inform.

18 What image did the writer use to explain density?
a fairy floss b chewing gum

Think About This

19 The diagram on page 2 shows
- a our sun.
- b a diagrammatic representation of a black hole.
- c a diagrammatic representation of the Milky Way.

20 The word *collapses* in section 1 could best be replaced with
a dies. b crumples. c fails. d expands.

21 Look at the diagram on page 2. What is at the centre of the black hole?
- a the Photon Sphere
- b the Event Horizon
- c the Singularity

22 How do scientists track the energy that is released by a star before it reaches the *event horizon*?
- a By sheer good luck.
- b By noting the X-ray radiation.
- c By measuring the difference between escape velocity and gravity.

23 According to the text, what took place at the centre of the Milky Way?
- a Two stars collided.
- b A giant star died.
- c Our sun was formed.

Challenge Option

Research: Find out if gravity is greater on Mars or Venus.