

# Synchrotron Investigations

## 2.4 The Synchrotron – *answers to student worksheet*

1. When do electrons release electromagnetic waves such as visible light or X-rays?

When the electrons accelerate, or move in a curved path.

2. Why were the electromagnetic waves emitted from the first particle accelerators originally considered a nuisance?

Because the electrons lose energy due to the fact that the electromagnetic waves carry away energy. The electrons then slow down.

3. How big was one of the first circular particle accelerators built by Lawrence?

Diameter = 12.7 cm

4. What is the circumference of the Australian Synchrotron?

216 m

5. List five uses for synchrotrons.

Medical imaging, forensics, environmental, minerals, micromachining, manufacturing, agriculture, material engineering.

6. What does Einstein's equation predict when the speed of an electron increases?

As the speed of the electron increases, its mass increases.

7. How many scientists will use the Australian Synchrotron?

More than 1200

8. Australia has a population of approximately 20 million people. How much money did each person have to contribute to build the Australian Synchrotron?

Approximately  $\$200 \text{ million} \div 20 \text{ million} = \$10 \text{ each}$

9. Given that a football stadium, such as the Telstra Dome in Melbourne, costs \$250 million to build. Do you think that building a synchrotron is a good investment by the Victorian Government?

Yes: there will be many benefits to mankind in the fields of medicine, science, and technology.

10. When Michael Faraday discovered electricity he was asked “What use is it?”, to which he responded “What use is a new born baby?”

Why would he make such a statement? Can you think of any reasons why scientific discoveries made with a synchrotron could be regarded as ‘new born babies’?

The future use for electricity wasn’t known – it had the potential to become very useful. Likewise, the discoveries made with the light from a synchrotron have the potential to be very useful to mankind in the fields of medicine, science and technology. But when discoveries are new, it is not clear what they will be used for in the fullness of time.

11. Consider the equation  $r = \frac{mv}{qB}$

To simplify the mathematics, let us assume that  $m=1$ ,  $q=2$  and  $B=1$ . What happens to  $r$  as  $v$  increases?

In which of the two particle accelerators shown below would the electrons be moving the fastest – the synchrotron in France or the cyclotron held by Lawrence?

The equation indicates that as the radius and velocity are proportional to each other for given values of  $m$ ,  $q$  and  $B$ . If  $v$  increases, then  $r$  will increase for given values of  $m$ ,  $q$  and  $B$

The synchrotron in France will have electrons moving at a faster speed.