



A. Key Concepts

1. Explain the difference between special relativity and general relativity with reference to inertial frames.
2. State the equivalence principle.
3. What effect does mass have on space time?
4. What arises as a result of the answer to 3?
5. What is a geodesic path?
6. Sketch an axis of position against time. Draw and label the world lines for
 - a) Stationary objects
 - b) objects at constant speed
 - c) accelerating objects
7. What is the event horizon of a black hole?
8. What is the escape velocity from the event horizon of a black hole?
9. What is the Schwarzschild radius of a black hole?
10. State the equation to calculate the Schwarzschild radius of a black hole?

B. Past Paper Questions

1. Cygnus X-1 is an X-ray source in the constellation Cygnus that astrophysicists believe contains a black hole. An artist's impression is shown in Figure 4A.

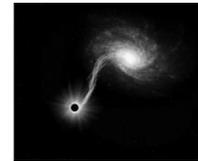


Figure 4A

The mass of the black hole has been determined to be 14.8 Solar masses.

- i. State what is meant by the Schwarzschild radius of a black hole. 1
- ii. Calculate the Schwarzschild radius of the black hole in Cygnus X-1. 3

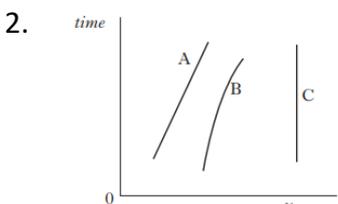


Figure 4A

- a) The world lines for three objects A, B and C are shown in Figure 4A. To which of these objects does the General Theory of Relativity apply? 2
Explain your choice.

- b) A rocket ship is accelerating through space. Clocks P and Q are at opposite ends of the ship as shown in Figure 4B. An astronaut inside the rocket ship is beside clock P and can also observe clock Q.

What does the astronaut observe about the passage of time for these clocks?

Justify your answer.

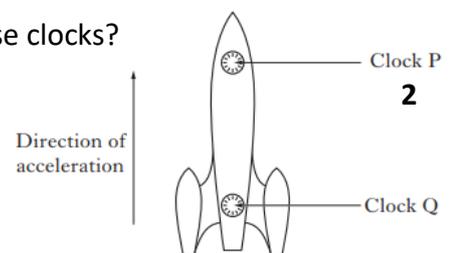


Figure 4B

3. Part of an astronaut's training is to experience the effect of "weightlessness".

This can be achieved inside an aircraft that follows a path as shown in Figure 4C.

Use the equivalence principle to explain how this "weightlessness" is achieved.

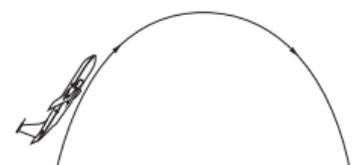


Figure 4C