**SOUTHERN RIVER COLLEGE**

**YEAR 12 PHYSICS**

***EVALUATION AND ANALYSIS***

***MODERN PHYSICS, 2022***

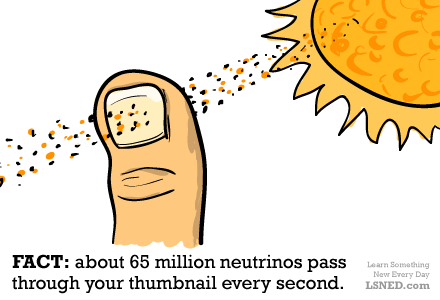
Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Marks: /42

INSTRUCTIONS TO CANDIDATES

Allowed time: 55 mins

* Answer all questions in the spaces provided.
* Give numerical answers to an **appropriate number of significant figures (not necessarily 3).**
* Credit may be obtained for method and working out despite an incorrect final answer, providing your solution to the problem is clearly set out.





1. There are three types of neutrino. List them. (1 mark)

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2. What is ‘neutrino oscillation’? (1 mark)

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3. Explain why neutrino oscillation might be the key for an explanation for why there is more matter than anti-matter in the universe. (2 marks)

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4. How are the neutrinos detected? Summarise the operation of the T2K Super-Kamiokande neutrino detector. (only the Super-Kamiokande **detector** – not the whole experiment) (2 marks)

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5. Why does so much water need to be used in the neutrino detector? (1 mark)

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6. Briefly explain Hubble’s Law. (2 marks)

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7. Why does the Hubble Constant change? (2 marks)

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8. How do astronomers measure the velocity of stars or galaxies relative to us? (2 marks)

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9. State three methods astronomers use to measure the distance to distant stars or galaxies. Briefly explain each. (6 marks)

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10. Synchrotrons and other particle accelerators are essentially similar devices, but with different purposes. Synchrotrons accelerate charged particles to produce ‘synchrotron light’ and other particle accelerators accelerate particles to produce collisions.

* 1. The term ‘synchrotron light’ implies that it is the production of visible light that makes it useful. Why is this not strictly accurate? (1 mark)

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* 1. How and where in the storage ring is the synchrotron light produced? (2 marks)

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* 1. List two special characteristics of synchrotron light that make it useful for researchers (1 mark)

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11. The linear accelerator stage at the Australian Synchrotron accelerates electrons to an energy of 100 MeV in 10 metres.

1. Using **Newtonian physics** only, calculate the speed of the electrons after this acceleration. (3 marks)
2. Use your answer to justify whether or not it is reasonable to ignore relativistic effects at an electron energy of 100 MeV as you did in the calculation in part (a) (1 marks)

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c. Repeat the calculation you did in a, this time using the expression for relativistic energy in your data sheet. Report your answer as a multiple of c, with as many significant figures as possible.(3 marks)

12. Superconducting electromagnets are used to ‘steer’ the charged particles around the circular beam line. Explain, with reference to an equation, why:

1. Such strong magnets are needed (2 marks)

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1. With consideration to your answer to part (a), why do you think very large diameter accelerators are needed to obtain the highest velocities (2 marks)

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13. There are 4 key pieces of evidence that supports the big bang model.

Briefly describe each of them. (8 marks)

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End of Test