**PHYSICS UNIT 4 SKILLS TEST 8 *(Special Relativity)* NAME\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

*(26 Marks, 26 Minutes)*

1. On the axes below, classical momentum as a function of velocity is shown. Sketch in the relativistic momentum as a function of velocity. [2 marks]

0 0.25 0.50 0.75 1.00 1.25 1

Same for low values ✓

Asymptote at ✓

1. With reference to the equation , explain why, as the speed of the electron increases, it becomes more difficult to accelerate. [3 Marks]

*As v gets closer to c, becomes closer to 1 and the denominator approaches zero.* ✓

*As a consequence the electron gets very heavy* ✓

*By Newtons Second Law, much more force is needed to accelerate it.* ✓

1. The distance between two solar systems is 4.2 light years. An astronaut makes her way between the two systems at a speed of 0.95c.
   1. How far does the astronaut observe the journey to be ? [2 marks]

✓

✓

b. How long does the astronaut observe the journey to take? [1 mark]

✓

c. Calculate the time of the journey as measured by an observer in one of the solar systems.

. [1 mark]

✓

4a) A star is receding from the Earth at a speed of 0.4 c. At what speed does its light reach an observer on Earth? [1 mark]

b) Which of the two (Star or Earth) experiences time dilation and what percentage dilation is it?

*They both experience time dilation from the perspective of the other* ✓ [4 marks]

✓✓

9 % or 91% (depending on which way you look at it) ✓

1. Calculate the momentum of a proton that has energy three times its rest energy. [5 marks]

Find velocity from mass-energy equivalence

✓

✓

✓

Find momentum using this velocity

✓ ✓

1. An ion wind is moving away at 0.20c from the perspective of a spacecraft. This spacecraft had taken off from a planet to move directly away from the ion wind. The planet based observatory monitors the spacecraft moving away at 0.65c. What velocity does the planet observatory observe the ion wind to have? [5 marks]

Ion wind

Planet

Spacecraft

✓

✓✓

towards planet

✓ ✓

Note: it is possible to use the other relativistic velocity equation if students reinterpret the velocities from the question. Which velocity is positive and negative can vary based on choice of direction convention.

6. What are the two postulates of Special Relativity?

*That there is no absolute motion ✓*

*That light travels at the same speed for all observers ✓*

[2 marks]