The Open University

Science Supplementary Material
S271 Discovering Physics

Computer Marked Assignment

Course and assignment number:
S271 45

Make sure you know how to use the CMA form: detailed instructions are given in your student handbook (or supplement).
You are strongly advised to attempt every question in this assignment.
If you do not wish to answer a question, pencil across the 'don't know' cell ('?').
If you think that a question is unsound in any way, pencil across the 'unsound' cell ('U') *in addition to* pencilling across either an answer cell or the 'don't know' cell.
Note For each question, you **must** *pencil across* **either** *the required number of answer cells* **or** *the 'don't know' cell.*

Covering: **Units 12–16**

Cut-off date:
Friday 4 October 1996

PART A

The questions in this part relate to Unit 12.

Q1 [*Special relativity*] Choose the *two* statements in the key that are *wrong*, and pencil across *two* cells in row 1.

KEY for Q1

A In a vacuum, light signals travel with a fixed speed relative to all observers who use inertial frames of reference.

B If an event E_1 causes another event E_2 then, according to any observer using an inertial frame of reference, it is *certain* that the distance between E_1 and E_2 will be *less* than, never equal to, the product of the speed of light c and the time that elapses between the two events.

C For two observers in different inertial frames of reference the principle of relativity is correct at speeds approaching that of light *and* at comparatively low speeds.

D In a vacuum, X-rays travel with a fixed speed relative to all observers who use inertial frames of reference.

E The special theory of relativity correctly relates the coordinates of an event observed by an observer O who is standing in the frame of reference of the ground and the coordinates of the same event observed by a second observer who is stationary in the frame of reference of a rocket that, according to O, is accelerating upwards from the ground.

F According to an observer at rest in Concorde, the length of the aircraft is constant, irrespective of its speed. (Assume that the observer is in an inertial frame of reference.)

G If the speed of light was infinite, the Galilean and Lorentz transformations would be identical.

Q2 [*Length contraction*] A rocket, which is travelling along the x-axis of an inertial frame P, moves along this x-axis with a constant speed $V = 3c/5$. It is measured by an observer in P to be 25 metres long. An observer on the rocket measures its length to be d. Choose from the key the *one* response that is closest to the value of d, and pencil across *one* cell in row 2.

KEY for Q2

A 15 m	E 25 m
B 20 m	F 21 m
C 31 m	G 42 m
D 41 m	H 32 m

Q3 [*Lorentz transformation*] Two events E_1 and E_2 are observed by two observers O and O′ who are stationary in their respective inertial frames. (The frames are in standard configuration and are not identical, i.e. $V \neq 0$). O observes that the two events are simultaneous and that they occur at different places on the x-axis separated by a distance s. *Use the Lorentz transformation* to choose from the key the *two* statements that are correct. Pencil across *two* cells in row 3.

KEY for Q3

A O′ must observe the events to be simultaneous.

B O′ cannot observe the events to be simultaneous.

C It is possible for O′ to observe the two events at the same place.

D O′ must observe the two events to occur at separation s.

E O′ must observe the two events to occur at different places at a separation $s' \neq s$.

Q4 [*Relativistic energy*] A particle of rest mass 1.2 kg is fixed at the origin of an inertial frame A. If another inertial frame B is travelling at speed $1000\,\mathrm{m\,s^{-1}}$ relative to frame A, what is the total relativistic energy of the particle according to an observer in frame B? Select the *one* response from the key that is closest to the correct answer, and pencil across *one* cell in row 4.

KEY for Q4

A 0.9×10^{17} J	D 4.9×10^{16} J
B 1.0×10^{17} J	E 1.1×10^{17} J
C 5.0×10^{16} J	F 6.0×10^{16} J