

PART C

Q12 Select the *two* statements from the key which are *false*. Pencil across *two* cells in row 12.

KEY for Q12

A The Michelson-Morley experiment was designed to undermine the ether theory of light propagation.

B The two postulates, SR1 and SR2, are inconsistent with the Galilean transformation between inertial observers.

C According to special relativity the equations of Maxwell's theory of electromagnetism are form invariant between inertial observers.

D Experiments carried out over a wide frequency range show that the speed of electromagnetic waves in a vacuum is independent of their frequency.

E Observations on binary stars indicate that the speed of electromagnetic waves in a vacuum is independent of the speed of the source.

F The Kennedy-Thorndike experiment proves that the speed of light in a vacuum is the same for all inertial frames.

G Two of the statements A to F are false.

Q13 An inertial observer, O, emits a series of light signals along his x -axis, which are reflected back to him by a distant mirror. He observes that the signal emitted at $t = 2$ s returns at $t = 4$ s, and that the signal emitted at $t = 5$ s returns at $t = 9$ s. Assuming that the mirror is at rest in an inertial reference frame, what is the equation of its world-line in O's

frame? Select one item from the key. Pencil across *one* cell in row 13.

KEY for Q13

A $x = c$

B $x = 2c$

C $x = (0.04 + 0.35t - 0.01t^2)c$

D $x = (0.25 + 0.25t)c$

E $x = (0.4 + 0.2t)c$

F $x = (-0.1 + 0.3t)c$

$ct = m\alpha + k$

Q14 and Q15 A light signal is emitted by an inertial observer, O, at time $t = T_1 > 0$, towards another inertial observer, O' who is moving directly away from O at speed $0.6c$. The time at which she receives the signal is recorded by O' as $t' = T_2'$. The clocks carried by O and O' are identical, and are synchronized at $t = t' = 0$ when they pass each other. The time of emission of the signal by O is $t' = T_1'$ on O's clock, and the time of receipt of the signal by O' is $t = T_2$ on O's clock.

Q14 What is the ratio T_2/T_1 ? Select one item from the key. Pencil across *one* cell in row 14.

Q15 What is the ratio T_2'/T_1' ? Select one item from the key. Pencil across *one* cell in row 15.

KEY for Q14 and Q15

A 1

B 1.25

C 1.6

D 1.75

E 2

F 2.5

G 3.2

PART D

Q16 to Q21 These questions refer to inertial observers O and O'. Relative to O, O' moves with speed $0.8c$ along the positive x^1 -axis, and the two coordinate systems coincide at $t = t' = 0$. At $t = 12$ s, O launches a projectile in the direction of O' from the origin of his frame, which travels at constant speed and explodes at $t = 25$ s. According to O, the explosion occurs at $x^1 = 1.5 \times 10^6$ km.

Q16 At what position x'^1 does the explosion occur according to O'? Select one item from the key. Pencil across *one* cell in row 16.

KEY for Q16

A -5.7×10^6 km

B -6.3×10^6 km

C -6.9×10^6 km

D -7.5×10^6 km

E -8.1×10^6 km

F -8.7×10^6 km

Q17 At what time t' does the explosion occur according to O'? Select one item from the key. Pencil across *one* cell in row 17.

KEY for Q17

A 25 s

B 27 s

C 29 s

D 31 s

E 33 s

F 35 s

Q18 What is the velocity of the projectile relative to O's frame? Select one item from the key. Pencil across *one* cell in row 18.

KEY for Q18

A $-0.8c$

B $-0.6c$

C $-0.4c$

D $-0.2c$

E $0.4c$

F $0.6c$

Q19 The key shows a number of options for two items, namely (i) the time, t_E , at which O sees the explosion, and (ii) the time, t'_E , at which O' sees the explosion. Pencil across *one* cell in row 19.

KEY for Q19

A 25 s 35 s

B 30 s 35 s

C 30 s 60 s

D 25 s 60 s

E 30 s 50 s

F 35 s 60 s