Forces – Q7 [8 marks] (2/6/21)

Exam Boards

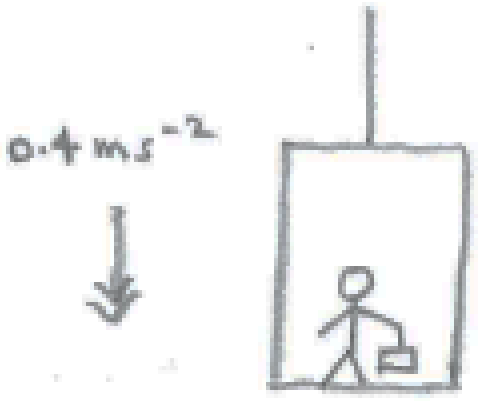
OCR : AL (Year 1)

MEI: AL (Year 1)

AQA: AL (Year 1)

Edx: AL (Year 1)

A man is in a lift, which is moving downwards with an acceleration of $0.4ms^{-1}$. The lift is suspended by a cable, and the man is holding a parcel by a light string, as in the diagram. The masses of the lift, man and parcel are 300kg, 80kg and 5kg, respectively.



(i) Find :

(a) the tension in the cable [2 marks]

(b) the reaction between the man and the floor of the lift

[2 marks]

(c) the tension in the string [2 marks]

(ii) Does the man feel heavier or lighter than he would if the lift were stationary and he were no longer carrying the parcel?

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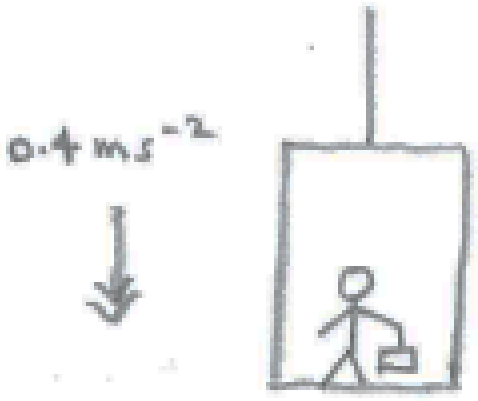

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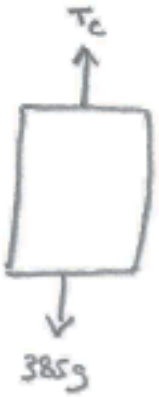
Solution

(a) Considering the lift, man and parcel as a single object:



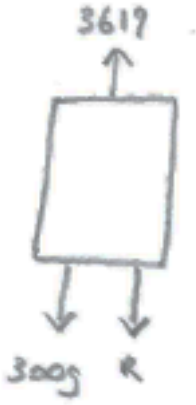
[T_C and 385g are the external forces]

$N2L \Rightarrow 385g - T_C = 385(0.4)$, where T_C is the tension in the cable [1 mark]

[any new symbols introduced need to be defined in an exam answer]

$\Rightarrow T_C = 385(9.8 - 0.4) = 3619\ N$ [1 mark]

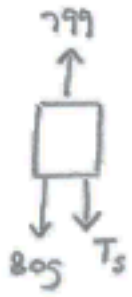
(b) Considering the forces on the lift:



$N2L \Rightarrow 300g + R - 3619 = 300(0.4)$, where R is the reaction between the man and the floor [1 mark]

$\Rightarrow R = 3619 + 120 - 300(9.8) = 799N$ [1 mark]

(c) Considering the forces on the man:



$N2L \Rightarrow 80g + T_S - 799 = 80(0.4)$, where T_S is the tension in the string [1 mark]

$\Rightarrow T_S = 799 + 32 - 80(9.8) = 47N$ [1 mark]

[Check: Considering the forces on the parcel:

$N2L \Rightarrow 5g - T_S = 5(0.4)$

$\Rightarrow T_S = 5(9.8) - 2 = 47N$]

(ii) If the lift is stationary and the man is not carrying the parcel, the reaction between himself and the floor is just his weight [see note below]: $80(9.8) = 784N$ [1 mark]

Thus he feels heavier, as $799 > 784$. [1 mark]

[The apparent gravity is now $9.8 - 0.4 = 9.4$, but the man's weight has effectively been increased by 5kg, giving a net apparent weight of

$85 \times 9.4 = 799N$ (this is a check on (b))]

Note: In the stationary situation (with no parcel),

$N2L \Rightarrow 80g - R' = 0 \Rightarrow R' = 80g$; ie the man's weight