20 An actor is wearing a harness. The harness is connected to a cable and support, as shown.
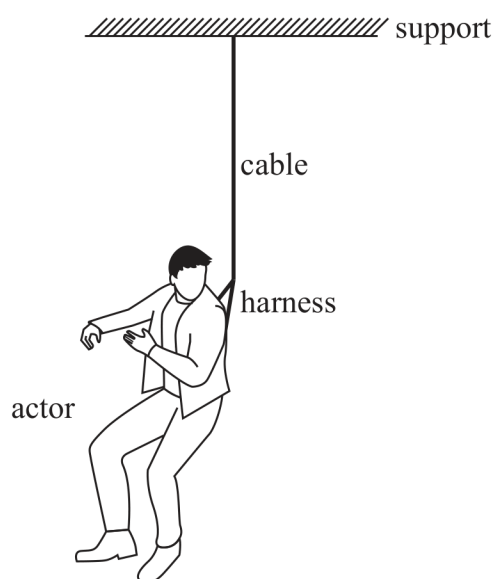

(a) The force on the cable must not cause the material of the cable to reach its yield point.

State what is meant by the yield point of a material.

(1)

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(b) The cable and harness are used to accelerate the actor vertically off the ground.

(i) Explain why the forces acting on the actor cause him to accelerate upwards.

(2)

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(ii) The actor has a mass of 77 kg and is lifted vertically from the ground with an acceleration of $2.1 \, m \, s^{-2}$.

Show that the tension in the cable is about 920 N.

(3)

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(iii) To make sure the actor is safe, the stress in the cable must be less than 15% of the yield point stress.

The cable has a yield point stress of $2.5 \times 10^8 \, Pa$.

The diameter of the cable is $7.6 \times 10^{-3} \, m$.

Deduce whether it is safe to lift the actor with an acceleration of $2.1 \, m \, s^{-2}$.

(4)

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(c) The original cable is replaced with a new cable made from a different material. This material has a lower Young modulus than the material used to make the original cable.

The new cable is the same length as the original cable but has a greater diameter.

The breaking stress is the same for both cables.

Explain how the work done to break the new cable is different from the work done to break the original cable. Assume that both materials obey Hooke's law up to the breaking point.

(4)

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(Total for Question 20 = 14 marks)