15 A gymnast bounces on a trampoline.
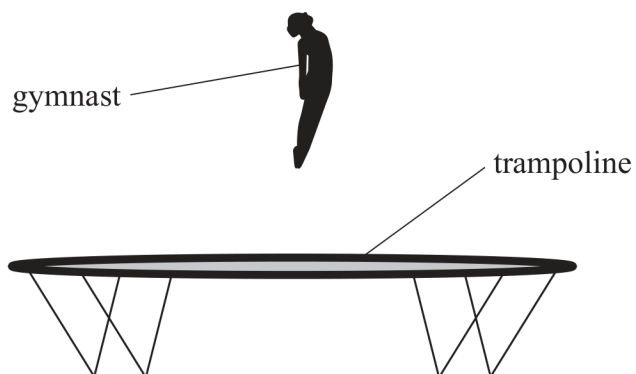
For part of each bounce, the gymnast is in contact with the trampoline. For the rest of each bounce the gymnast is in the air, as shown.

gymnast

trampoline

(a) The trampoline gives the gymnast a maximum upward acceleration of $14.2\,\mathrm{m\,s^{-2}}$.

Calculate the maximum upward force of the trampoline on the gymnast.

mass of gymnast = 58 kg

(4)

....

....

....

....

....

....

Maximum upward force = ...

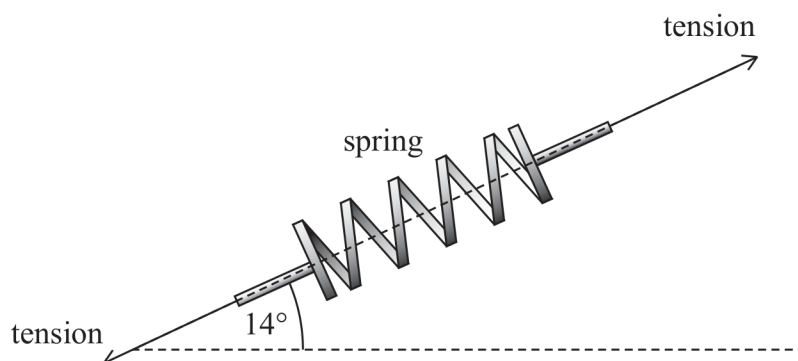P 7 1 8 6 4 A 0 1 6 2 8

(b) The trampoline is made of a sheet of material attached to a frame by springs.

The vertical components of the tension in the springs provide the upward force on the gymnast.

The vertical component of the tension in one spring is 68 N when the spring makes an angle to the horizontal of 14°, as shown below.

Not to scale

(i) Show that the tension in the spring is about 300 N.

(2)

....

....

....

....

(ii) The extension of the spring was 4.6×10^{-2} m.

Calculate the stiffness of the spring.

(2)

....

....

....

Stiffness = ...

*(c) The vertical acceleration of the gymnast varies while she is in contact with the trampoline.

Explain how the forces on the gymnast affect the vertical acceleration while she is in contact with the trampoline.

Your answer should identify the forces acting on the gymnast and the directions of the forces. Ignore air resistance.

(6)

....

....

....

....

....

....

....

....

....

....

....

....

(Total for Question 15 = 14 marks)