Questions

Q1.

* The photograph shows a toy car that contains a spring. Pulling the car backwards along the floor compresses the spring. Energy is stored in the compressed spring.

The car is released and the spring returns to its original state. There is a forward force on the car from the floor and the car moves forwards.

Explain why the floor exerts a forward force on the car and how this force affects the motion of the car as the spring returns to its original state.

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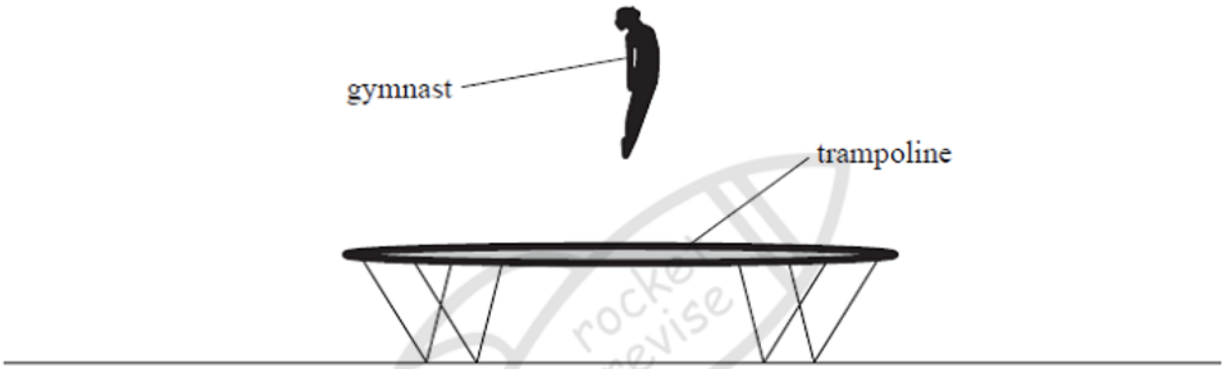
(Total for question = 6 marks)

Q2.

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.



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

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

mass of gymnast = 58 kg

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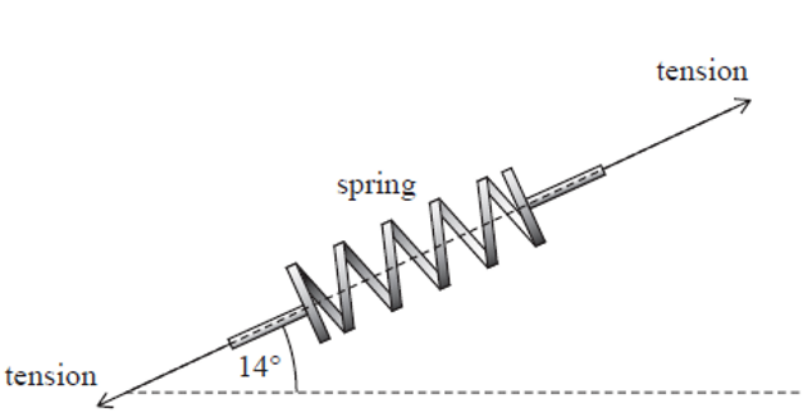
Maximum upward force = ...

(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.



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

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

Calculate the stiffness of the spring.

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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.

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(Total for question = 14 marks)

Q3.

Which of the following is a vector quantity?

☒ **A** density

☒ **B** kinetic energy

☒ **C** momentum

☒ **D** viscosity

(Total for question = 1 mark)

Q4.

Answer the question with a cross in the box you think is correct (☒). If you change your mind, put a line through the box (☒) and then mark your new answer with a cross (☒).

When compressed by a force of 50 N, a spring had a length of 12.0 cm.

When compressed by a force of 70 N, the same spring had a length of 7.1 cm.

Which of the following expressions gives the stiffness k of the spring in N cm^{-1}?

☒ **A** $\frac{70}{12.0} - \frac{50}{7.1}$

☒ **B** $\frac{(70 - 50)}{(12.0 - 7.1)}$

☒ **C** $\frac{50}{7.1} - \frac{70}{12.0}$

☒ **D** $\frac{(70 - 50)}{(12.0 - 4.9)}$

(Total for question = 1 mark)

Q5.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Two identical springs are arranged in series. A force of 45.0 N is applied to the springs, as shown.

The springs extend a total distance of 15 mm.

Which of the following expressions gives the stiffness of each spring in N mm^{-1}?

☒ **A** $\frac{15}{2 \times 45}$

☒ **B** $\frac{45}{2 \times 15}$

☒ **C** $\frac{2 \times 15}{45}$

☒ **D** $\frac{2 \times 45}{15}$

(Total for question = 1 mark)

Q6.

A student is investigating a material in the form of a wire.

Which of the following properties of the wire will change if a longer wire is used?

☒ **A** breaking stress

☒ **B** density

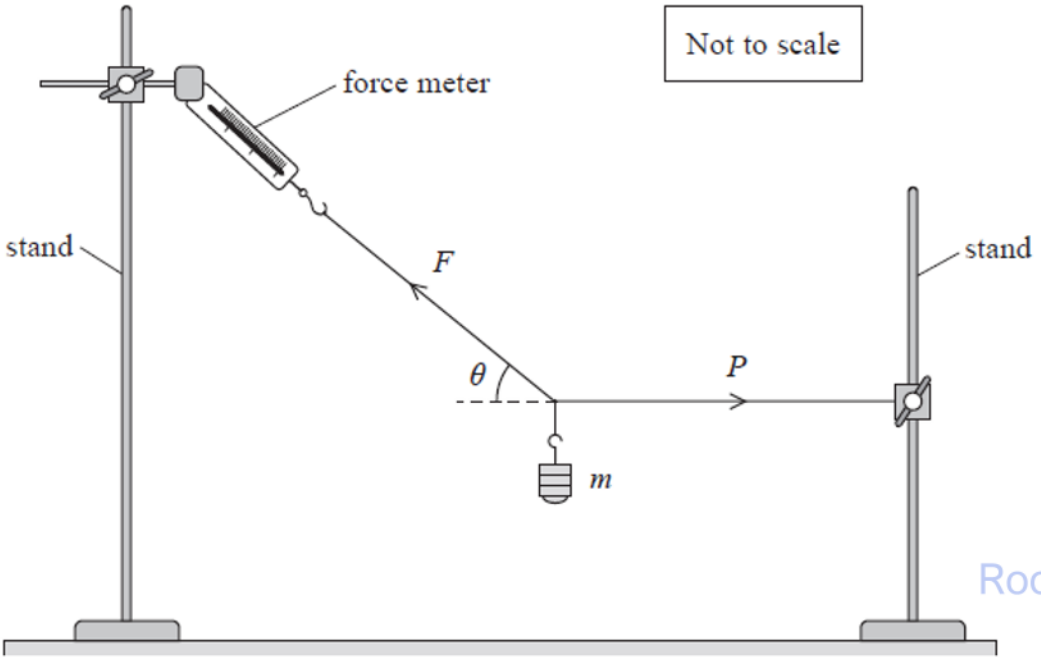
☒ **C** stiffness

☒ **D** Young modulus

(Total for question = 1 mark)

Q7.

A mass *m* is held in equilibrium by strings attached to two clamp stands. The force meter records the force *F* in the upper string. The force in the horizontal string is *P*. The angle made by the upper string to the horizontal is θ, as shown.



(a) The force meter allows force to be measured by means of Hooke's law.

The extension of the spring inside the force meter allows the stretching force to be read from a scale.

When the force applied to stretch the spring is 15 N the extension of the spring is 8.0 cm.

Show that the stiffness of the spring is about 2 N cm^{-1}.

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(b) When m is equal to 0.55 kg, the value of P is 8.5 N.

Calculate the value of θ, and the extension of the spring in the force meter.

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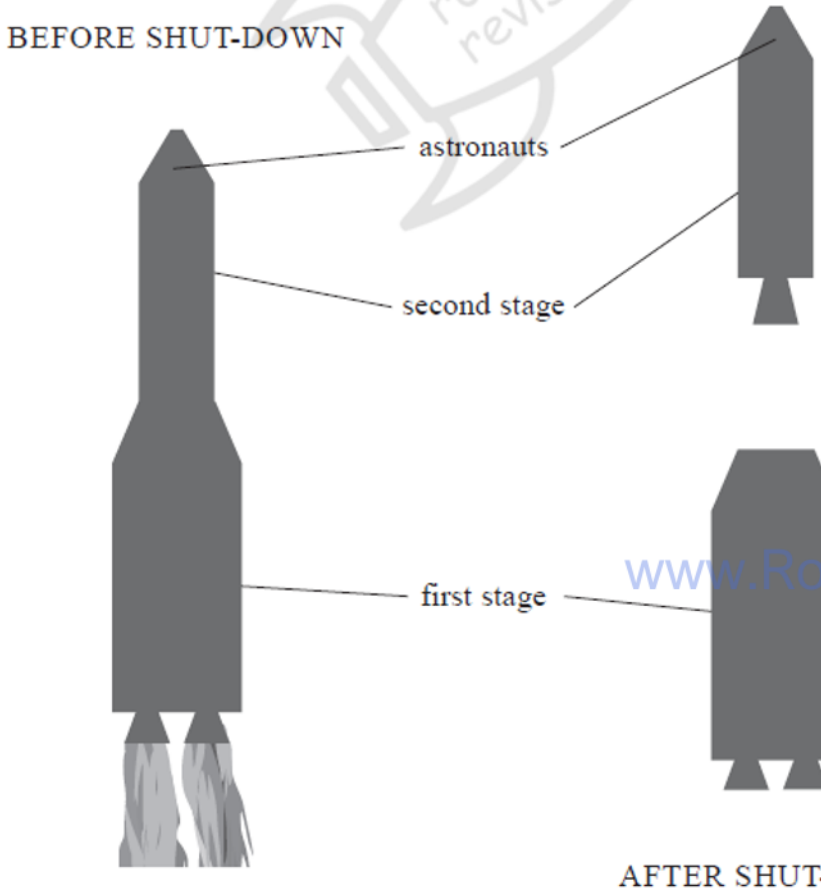
θ = ...

Extension of the spring = ...

(Total for question = 8 marks)

Q8.

*A large spacecraft is made up of several 'stages'. Each stage consists of a rocket motor and a fuel tank. Once a stage has used all its fuel, the rocket motor in that stage shuts down. The stage then disconnects from the spacecraft and falls back to Earth.



As the rocket is rising due to the upward force of the first stage, an astronaut feels himself pushed further and further back, compressing the back of his seat.

When the first stage shuts down, the astronaut is suddenly projected forwards by the seat. The

astronaut is held in place by a safety strap.

Explain the effects experienced by the astronaut. You may assume that the force provided by the first stage rocket motor is constant until the moment it shuts down.

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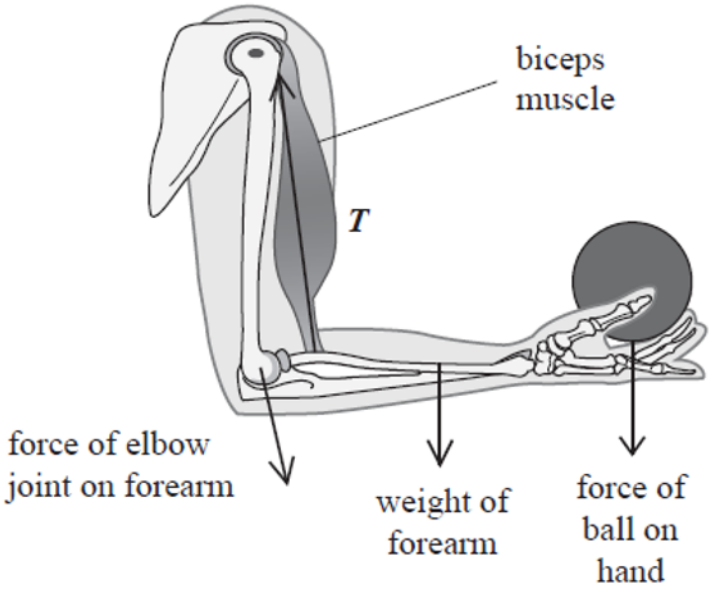
(Total for question = 6 marks)

Q9.

Muscles move body parts by contracting and relaxing. For the forearm to hold a ball in the position shown, the biceps muscle contracts, creating a tension *T* in the muscle as shown.



A student modelled the forces on the forearm using a uniform beam and spring arrangement as shown below. The length and weight of the beam were the same as the length and weight of the forearm.

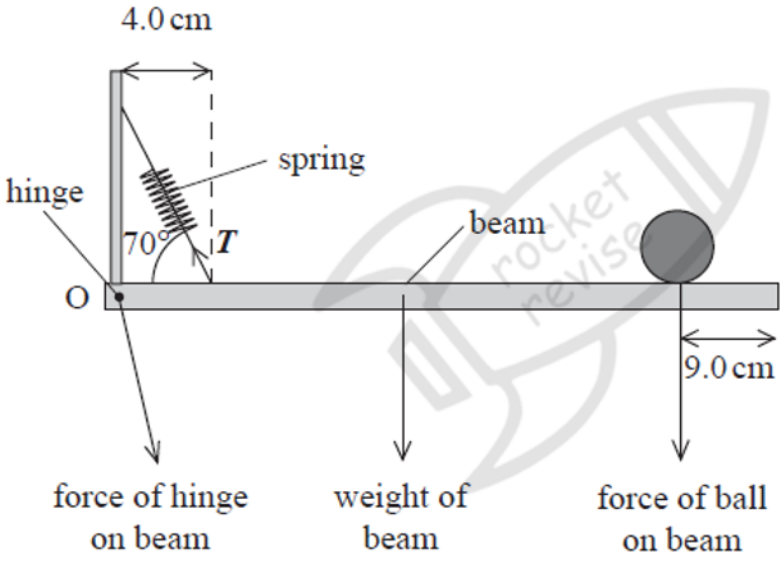


Diagram not to scale

(a) It can be assumed that the biceps muscle acts as a spring at an angle of 70° to the beam, 4.0 cm from the pivot O.

Determine the magnitude of *T*. You will need to estimate the total length of the forearm and hand.

force of ball on beam = 4.5 N
weight of beam = 15 N

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Estimate of total length of forearm and hand = ...

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T = ...

(b) Explain a limitation of using a beam to model the forearm.

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(Total for question = 7 marks)