3 When a force F is applied to a spring with stiffness k, the elastic potential energy stored is E.

What is the elastic potential energy stored when a force $2F$ is applied to a spring with stiffness $2k$?

☒ **A** $\frac{E}{2}$

☒ **B** E

☒ **C** $2E$

☒ **D** $8E$

(Total for Question 3 = 1 mark)

4 There are several different methods that can be used to determine the distance from our solar system to astronomical objects. These include the measurement of red shift, trigonometrical parallax and the use of standard candles.

Which row of the table shows a suitable method for each of the objects named?

	Nearby star	Nearby galaxy	Very distant galaxy
☒ **A**	parallax	red shift	standard candle
☒ **B**	red shift	standard candle	parallax
☒ **C**	parallax	standard candle	red shift
☒ **D**	red shift	parallax	standard candle

(Total for Question 4 = 1 mark)

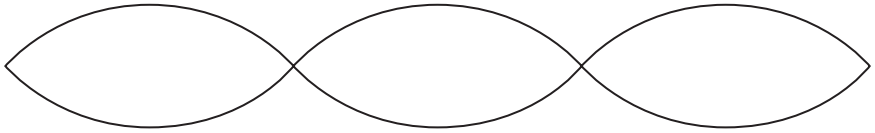
15 The photograph shows a guitar.

When a guitar string is plucked, a standing wave is created.

(a) Explain how a standing wave is created on the string.

(3)

(b) The diagram shows a standing wave on a guitar string.



The oscillating length of the guitar string is 66 cm.

(i) State the wavelength for this standing wave.

(1)

Wavelength = ...

(ii) Calculate the frequency of vibration for this standing wave.

tension in guitar string = 88.6 N

mass per unit length of guitar string = 4.47×10^{-3} kg m^{-1}

(3)

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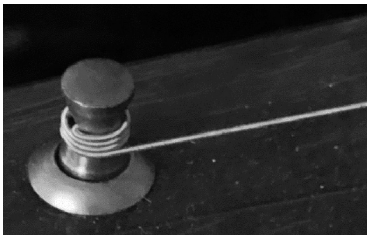
.....

Frequency = ...

(c) One end of the guitar string is wrapped around a cylindrical tuning peg. Turning the peg changes the total length of the string and hence changes the tension in the string. This changes the frequency of vibration of the string.



(i) The length of one string is 68 cm.

Calculate the extension required to produce a tension of 93.4 N in the string.

Young modulus of string material = $1.8 \times 10^{9}\,\text{N m}^{-2}$

cross-sectional area of string = $6.6 \times 10^{-7}\,\text{m}^{2}$

(4)

Extension = ...

(ii) The vibrating length of string is unchanged by turning the tuning peg.

Explain the effect that tightening the string has on the frequency of the sound produced.

(2)

.....

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.....

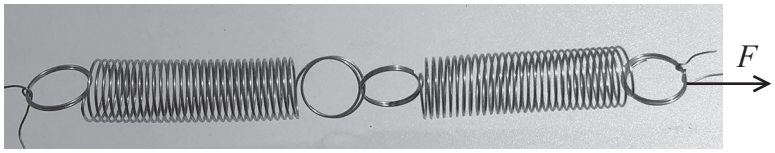
(Total for Question 15 = 13 marks)

Questions 3 and 4 refer to the following information.

A horizontal force F is applied to a horizontal spring, fixed at one end.

The stiffness of the spring is k and the elastic strain energy stored is E.

A second, identical spring is added and the same force is applied to the combination of springs, as shown.



3 What is the stiffness of the combination of springs?

- ☒ **A** $\frac{k}{2}$
- ☒ **B** k
- ☒ **C** $2k$
- ☒ **D** $4k$

(Total for Question 3 = 1 mark)

4 What is the elastic strain energy stored for the combination of springs?

- ☒ **A** $\frac{E}{2}$
- ☒ **B** E
- ☒ **C** $2E$
- ☒ **D** $8E$

(Total for Question 4 = 1 mark)

5 A mass of 24 kg is suspended from a steel wire of length 1.5 m. The wire has cross-sectional area $3.1 \times 10^{-6}\,m^2$.

The Young modulus of steel is 1.8×10^{11} Pa.

Which of the following gives the extension of the wire?

☒ **A** $\dfrac{24 \times 1.5}{1.8 \times 10^{11} \times 3.1 \times 10^{-6}}$

☒ **B** $\dfrac{24 \times 9.81 \times 1.5}{1.8 \times 10^{11} \times 3.1 \times 10^{-6}}$

☒ **C** $\dfrac{1.8 \times 10^{11} \times 3.1 \times 10^{-6}}{24 \times 1.5}$

☒ **D** $\dfrac{1.8 \times 10^{11} \times 3.1 \times 10^{-6}}{24 \times 9.81 \times 1.5}$

(Total for Question 5 = 1 mark)

6 The diagram shows a source of sound waves and an observer.

Which row of the table shows a situation which would result in a decrease in the frequency of sound observed?

	Source	Observer
☒ **A**	moves to the right at 20 m s^{-1}	moves to the left at 20 m s^{-1}
☒ **B**	moves to the right at 20 m s^{-1}	moves to the right at 20 m s^{-1}
☒ **C**	moves to the right at 20 m s^{-1}	stationary
☒ **D**	stationary	moves to the right at 20 m s^{-1}

(Total for Question 6 = 1 mark)