Solids (MCQ Only)

Q1.

A deforming force is applied to a sample of material.

Which row of the table shows the axes of a graph for which the gradient is stiffness *k*?

	y-axis	*x*-axis
☒ **A**	extension	force
☒ **B**	force	length
☒ **C**	stress	strain
☒ **D**	strain	length

(Total for question = 1 mark)

Q2.

A sample of steel in the form of a wire is subjected to an increasing load.

Which of the following is the best description of the elastic limit of the steel?

☒ **A** The stress at which the steel undergoes an increase in strain with no increase in stress.

☒ **B** The stress beyond which the stress and strain are no longer proportional.

☒ **C** The stress beyond which the steel becomes permanently deformed.

☒ **D** The stress at which the steel breaks.

(Total for question = 1 mark)

Q3.

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 2*F* is applied to a spring with stiffness 2*k*?

☒ **A** $\frac{E}{2}$

☒ **B** E

☒ **C** $2E$

☒ **D** $8E$

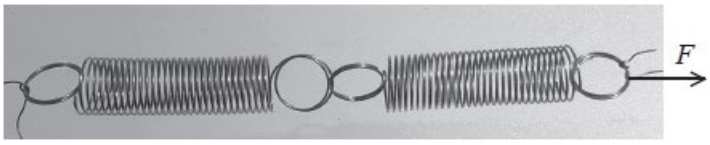
(Total for question = 1 mark)

Q4.

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.



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

☒ **A** $\frac{E}{2}$

☒ **B** E

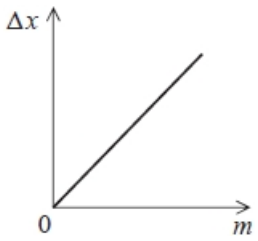
☒ **C** $2E$

☒ **D** $8E$

(Total for question = 1 mark)

Q5.

A spring is hung vertically and masses are added to the lower end.
The graph shows how the extension Δ*x* of the spring varies with the mass *m* added.



The work done in extending the spring can be expressed as

(1)

☒ **A** $mg\Delta x$

☒ **B** $\frac{mg}{\Delta x}$

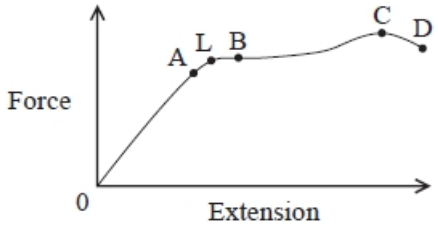
☒ **C** $\frac{1}{2}mg\Delta x$

☒ **D** $\frac{mg}{2\Delta x}$

(Total for question = 1 mark)

Q6.

The diagram shows a force-extension graph for a wire.



L is the elastic limit.

Which point represents the yield point?

(1)

☒ **A**
☒ **B**
☒ **C**
☒ **D**

(Total for question = 1 mark)

Q7.

The Hooke's law equation is:

$$\Delta F = k\Delta x$$

Which of the following gives the base units of k?

- **A** kg s^{-2}
- **B** kg m s^{-2}
- **C** N m
- **D** N m^{-1}

(Total for question = 1 mark)

Q8.

A mass is supported by a single spring as shown.

The strain energy stored by the spring is E.

The mass is then supported by two springs, each identical to the first spring, as shown.

What is the total strain energy stored with two springs arranged in this way?

☒ **A** ¼ *E*

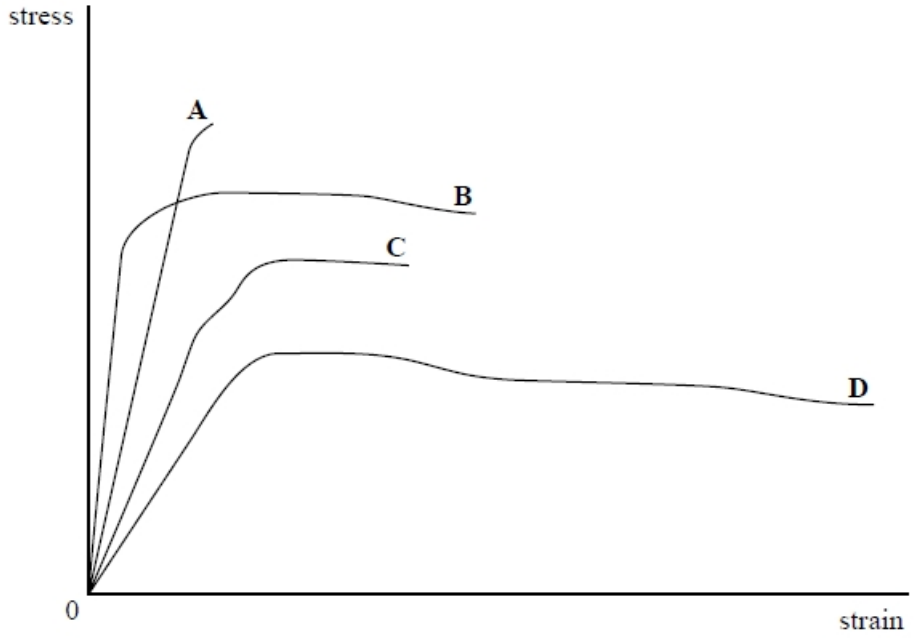
☒ **B** ½ *E*

☒ **C** *E*

☒ **D** 2*E*

(Total for question = 1 mark)

Q9.



Which of the materials represented in the graph has the largest value of the Young Modulus?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for question = 1 mark)

Q10.

In an investigation to determine the Young modulus of steel in the form of a wire, a student plots a straight line graph. The Young modulus is numerically equal to the gradient of the graph.

What quantities did the student plot on each axis on the graph?

		y-axis	*x*-axis
☒	**A**	strain	stress
☒	**B**	stress	strain
☒	**C**	$\frac{1}{\text{strain}}$	stress
☒	**D**	$\frac{1}{\text{stress}}$	strain

(Total for question = 1 mark)

Q11.

The following measurements were made to determine the Young modulus of a metal bar.

original length of bar = 0.50 m
area of cross section = 4.5×10^{-4} m^2
tensile force applied to bar = 36 000 N
extension of bar = 2.0×10^{-4} m

Which of the following gives the Young modulus of the metal?

☒ **A** $\frac{36000 \times 0.50}{4.5 \times 10^{-4} \times 2.0 \times 10^{-4}}$

☒ **B** $\frac{4.5 \times 10^{-4} \times 2.0 \times 10^{-4}}{36000 \times 0.50}$

☒ **C** $\frac{36000 \times 2.0 \times 10^{-4}}{4.5 \times 10^{-4} \times 0.50}$

☒ **D** $\frac{4.5 \times 10^{-4} \times 0.50}{36000 \times 2.0 \times 10^{-4}}$

(Total for question = 1 mark)

Q12.

The Young Modulus of a material can be expressed by the formula $E = \frac{Fx}{A\Delta x}$.

The derivation of this formula is

$E = \frac{\sigma}{\varepsilon}$

So $E =$ .....

And $E = \frac{Fx}{A\Delta x}$

Which of the following completes the second line of the derivation?

☒ **A** $\frac{\frac{x}{\Delta x}}{\frac{F}{A}}$

☒ **B** $\frac{\frac{\Delta x}{x}}{\frac{F}{A}}$

☒ **C** $\frac{\frac{F}{A}}{\frac{\Delta x}{x}}$

☒ **D** $\frac{\frac{F}{A}}{\frac{x}{\Delta x}}$

(Total for question = 1 mark)

Mark Scheme - Solids (MCQ Only)

Q1.

Question Number	Acceptable answers	Additional guidance	Mark
	The only correct answer is B because the gradient of this graph is change in length ÷ change in force and the change in length is the same as the change in extension, so the gradient is equal to stiffness A is not correct because a graph of extension against force will have a gradient of $1/k$ C is not correct because a graph of stress against strain will have a gradient equal to the Young modulus for the sample D is not correct because a graph of strain versus length is equivalent to a graph of extension versus (length)^2, so it does not have a gradient equal to k		1

Q2.

Question Number	Answer	Mark
	C The stress beyond which the steel becomes permanently deformed.	1
	Incorrect Answers: A – The stress at which the steel undergoes an increase in strain with no increase in stress. B – The stress beyond which the stress and strain are no longer proportional. D – The stress at which the steel breaks.	

Q3.

Question Number	Acceptable answer	Additional guidance	Mark
	C	The only correct answer is C because for the original spring $F = kx$ so $x = F/k$, so $E = ½ Fx = ½ F^2/k$. For $2F$ and $2k$ the epe is $E \times 2^2 / 2 = 2E$ A is not correct because it is $E/2$ B is not correct because it is E A is not correct because it is $8E$	1

Q4.

Question Number	Answer	Mark
	The only correct answer is C because each spring is extended by the same amount so each stores the same energy so the total is doubled	1

Q5.

Question Number	Answer	Mark
	C $\frac{1}{2}mg\Delta x$	1
	Incorrect Answers: A – no factor of $\frac{1}{2}$ B – incorrect equation and no factor of $\frac{1}{2}$ D – incorrect equation	

Q6.

Question Number	Acceptable answers	Additional guidance	Mark
	B		1

Q7.

Question Number	Answer	Mark
	A kg s^{-2}	1
	Incorrect Answers: B – base units for N C – incorrect units and not base units D – correct units but not base units	

Q8.

Question Number	Acceptable answer	Additional guidance	Mark
	B	The only correct answer is **B**: for each spring, ½ force, so ½ extension, so ½ *Fx* gives ¼ *E*, so total is ½ *E* A is not correct because it is the energy for one spring with this extension C is not correct because it only applies the factor of ½ once D is not correct because it is the energy for two springs, each with the original extension	1

Q9.

Question Number	Acceptable Answers	Additional Guidance	Mark
	B		1

Q10.

Question Number	Answer	Mark
	B stress v strain	1
	Incorrect Answers: **A** – gradient ≠ Young modulus **C** – gradient ≠ Young modulus **D** – gradient ≠ Young modulus	

Q11.

Question Number	Answer	Mark
	A $\frac{36000\times0.5}{4.5\times10^{-4}\times2.0\times10^{-4}}$	1
	Incorrect Answers: B – incorrect arrangement of equation C– incorrect arrangement of equation D – incorrect arrangement of equation	

Q12.

Question Number	Answer	Mark
	C $\frac{F/A}{\Delta x/x}$ **(stress/strain)**	1
	Incorrect Answers: A incorrect arrangement B incorrect arrangement D incorrect arrangement for strain	