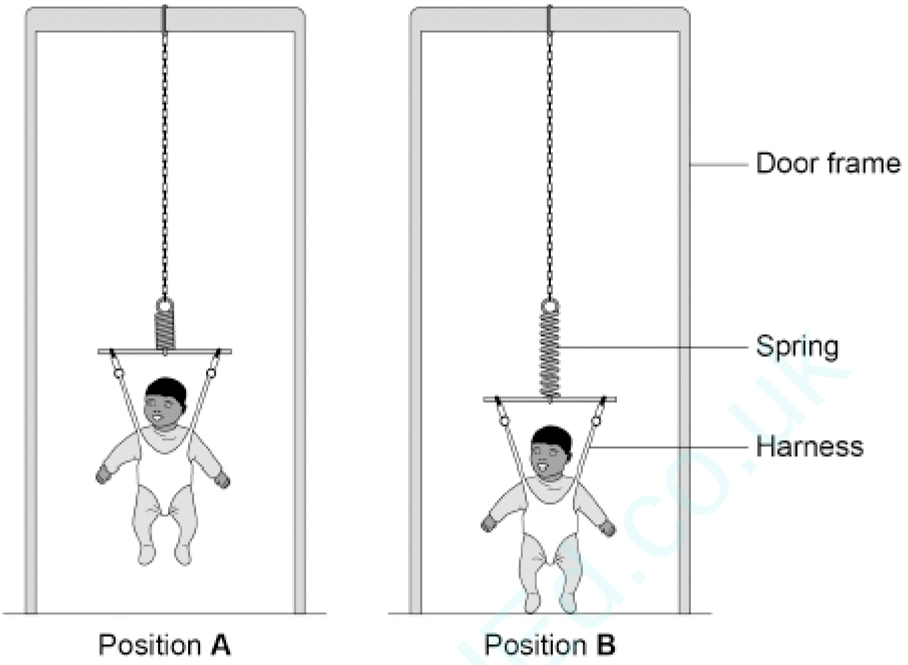
INSIGHTFUL EDUCATION

Q1.

A baby bouncer is a harness attached to a spring that hangs from a door frame.

The figure above shows a baby in a baby bouncer in two positions.



(a) The baby bouncer should not be used with babies that have a mass greater than 12 kg.

Suggest **one** reason why.

___

___

___

(1)

(b) In positions **A** and **B** the baby is stationary.

Describe the energy transfers as the baby moves from position **A** to position **B**.

___

___

___

___

___

___

(3)

(c) In one position the extension of the spring is 8.0 cm.

www.insightfuled.co.uk

INSIGHTFUL EDUCATION

The elastic potential energy stored by the spring is 4.0 J.

Calculate the spring constant of the spring.

Use the Physics Equations Sheet.

___

___

___

___

___

___

___

Spring constant = ____________ N/m

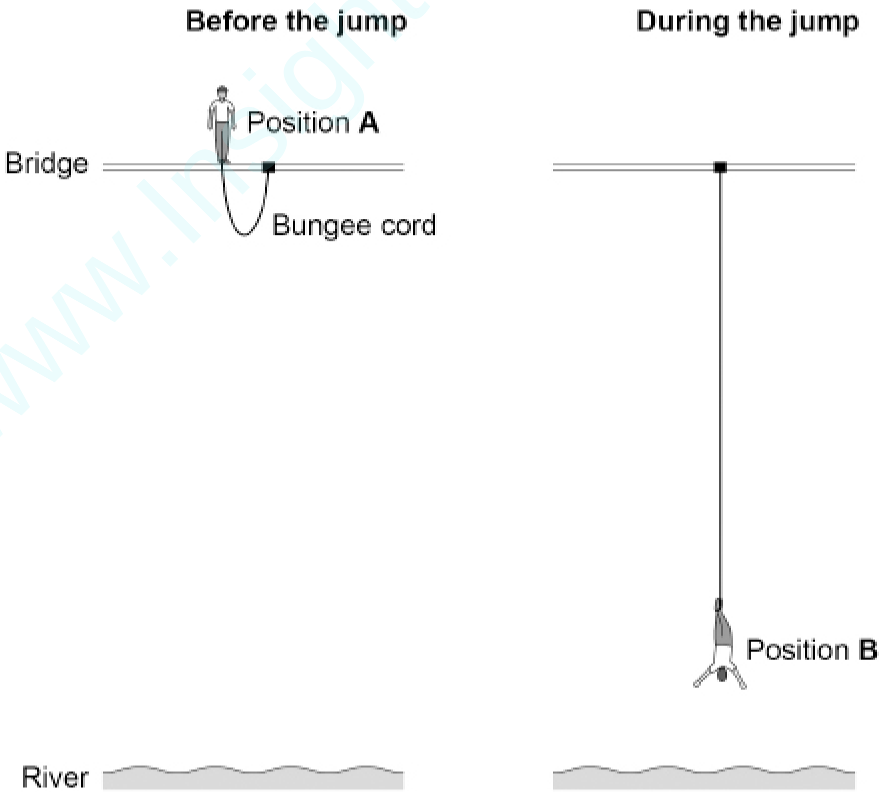
(4)

(Total 8 marks)

Q2.

The figure below shows a student before and during a bungee jump.

The diagram is not to scale.



(a) In position **B**, the student is moving towards the river and the bungee cord is stretching.

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

How do the energy stores in position **B** compare with the energy stores in position **A**?

Tick (✓) **one** box in **each** row.

Energy store	**Less than at A**	**The same as at A**	**More than at A**
The student's gravitational potential energy			
The student's kinetic energy			
The bungee cord's elastic potential energy			

(3)

(b) The bungee cord behaves like a spring with a spring constant of 78.4 N/m.

At one point in the bungee jump, the extension of the bungee cord is 25 m.

Calculate the elastic potential energy stored by the bungee cord.

Use the equation:

elastic potential energy = 0.5 × spring constant × extension^2

___

___

___

Elastic potential energy = ____________________ J

(2)

www.InsightfulEd.co.uk

The table below shows information about different bungee cords.

Bungee cord	**Spring constant in N/m**	**Maximum extension before snapping in metres**
A	78.4	36
B	82.0	24
C	84.5	12

(c) Bungee cord **C** will have a smaller extension than **A** or **B** for any bungee jumper.

Give the reason why.

___

___

INSIGHTFUL EDUCATION

(1)

(d) Which bungee cord would be safest to use for a person with a large weight?

Give a reason for your answer.

Bungee cord ___________

Reason ____

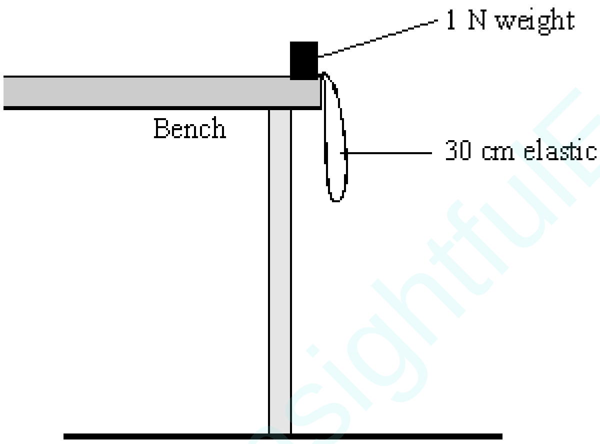
____

____

(2)
(Total 8 marks)

Q3.

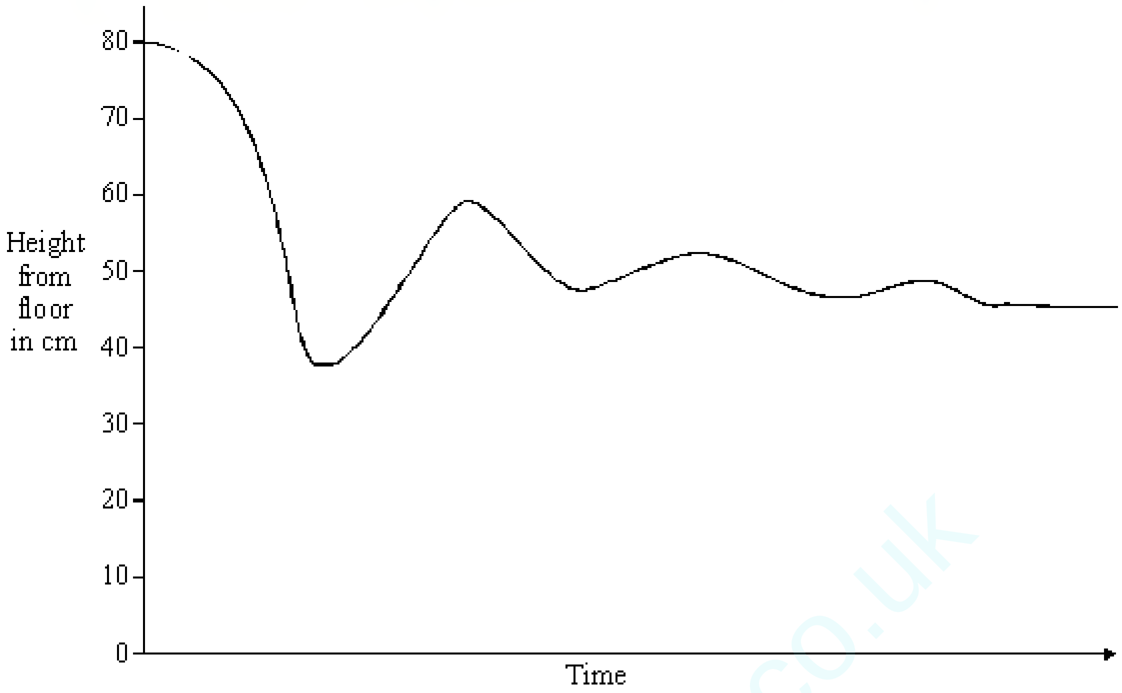
A 1 N weight is tied to a 30 cm long piece of elastic. The other end is fixed to the edge of a laboratory bench. The weight is pushed off the bench and bounces up and down on the elastic.



The graph shows the height of the weight above the floor plotted against time, as it bounces up and down and quickly comes to rest.

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION



(a) Mark on the graph a point labelled **F**, where the weight stops falling freely.

(1)

(b) Mark on the graph a point labelled **S**, where the weight finally comes to rest.

(1)

(c) Mark **two** points on the graph each labelled **M**, where the weight is momentarily stationary.

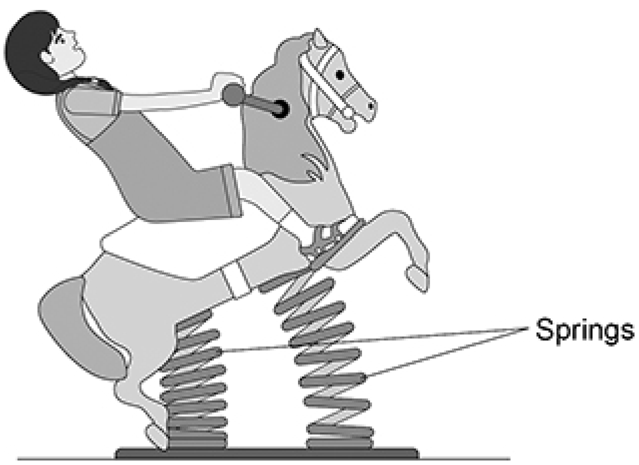
(1)

(Total 3 marks)

Q4.

Figure 1 below shows a child on a playground toy.

Figure 1



(a) The springs have been elastically deformed.

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

Explain what is meant by 'elastically deformed'.

___

___

___

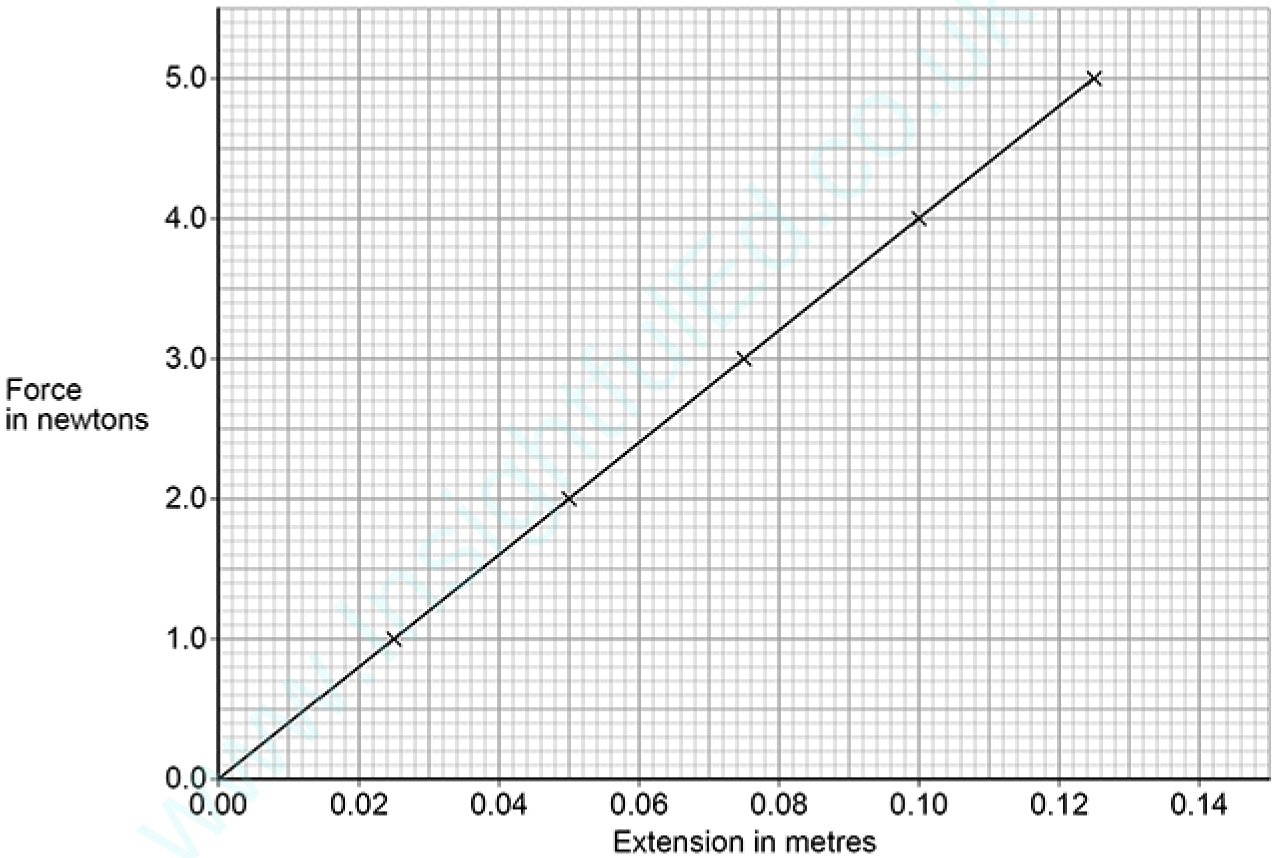
___

(2)

PRACTICAL: A student investigated the relationship between the force applied to a spring and the extension of the spring.

Figure 2 below shows the results.

Figure 2



(b) Describe a method the student could use to obtain the results given in **Figure 2**.

You should include a risk assessment for **one** hazard in the investigation.

Your answer may include a diagram.

INSIGHTFUL EDUCATION

(6)

(c) Which equation links extension (e), force (F) and spring constant (k).

Tick (✓) **one** box.

force = spring constant × (extension)^2 ☐

force = spring constant × extension ☐

force = $\frac{\text{extension}}{\text{spring constant}}$ ☐

force = $\frac{\text{spring constant}}{\text{extension}}$ ☐

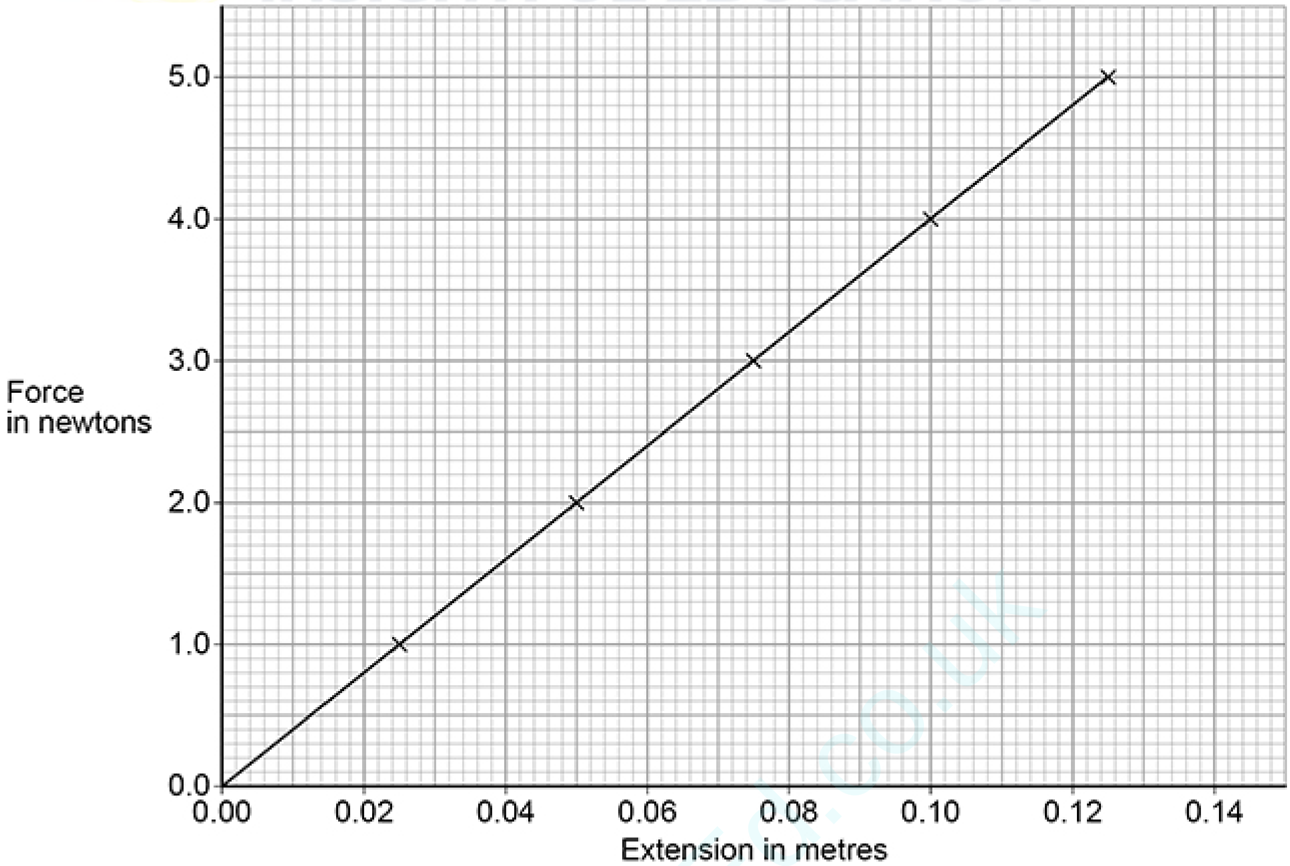
(1)

Figure 2 is repeated below.

Figure 2

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION



(d) Determine the spring constant of the spring.

Use **Figure 2**.

____

____

____

____

____

Spring constant = ________________ N/m

(3)

(e) The student concluded:

'The extension of the spring is directly proportional to the force applied to the spring.'

Describe how **Figure 2** supports the student's conclusion.

____

____

____

____

(2)

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

(f) The student repeated the investigation using a different spring with a spring constant of 13 N/m.

Calculate the elastic potential energy of the spring when the extension of the spring was 20 cm.

Use the Physics Equations Sheet.

____

____

____

____

____

____

Elastic potential energy = ______________ J

(3)

(Total 17 marks)

www.InsightfulEd.co.uk

Q5.

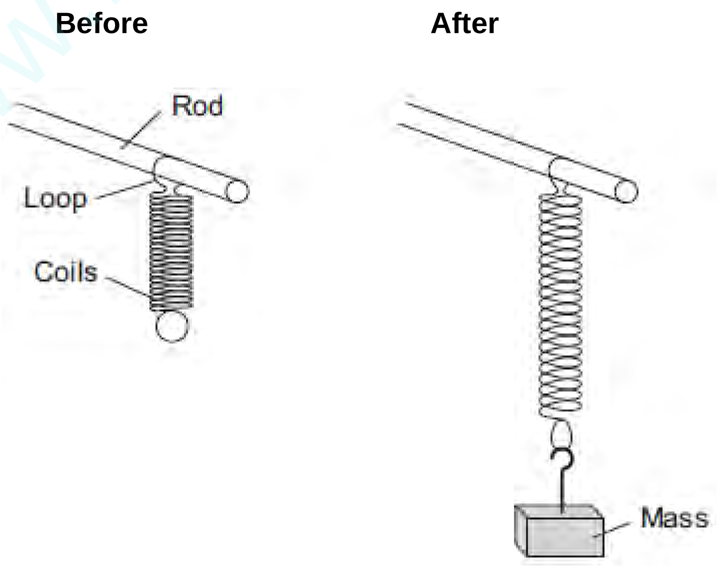
A student investigated the behaviour of springs. She had a box of identical springs.

(a) When a force acts on a spring, the shape of the spring changes.

The student suspended a spring from a rod by one of its loops. A force was applied to the spring by suspending a mass from it.

Figure 1 shows a spring before and after a mass had been suspended from it.

Figure 1



(i) State **two** ways in which the shape of the spring has changed.

INSIGHTFUL EDUCATION

1. ______________________________

2. ______________________________

(2)

(ii) No other masses were provided.

Explain how the student could test if the spring was behaving elastically.

____

____

____

____

(2)

(b) In a second investigation, a student took a set of measurements of force and extension.

Her results are shown in **Table 1** .

Table 1

Force in newtons	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Extension in cm	0.0	4.0		12.0	16.0	22.0	31.0

(i) Add the missing value to **Table 1**.

Explain why you chose this value.

____

____

____

____

(3)

(ii) During this investigation the spring exceeded its limit of proportionality.

Suggest a value of force at which this happened.

Give a reason for your answer.

Force = ______________ N

Reason ______________________________

____

____

(2)

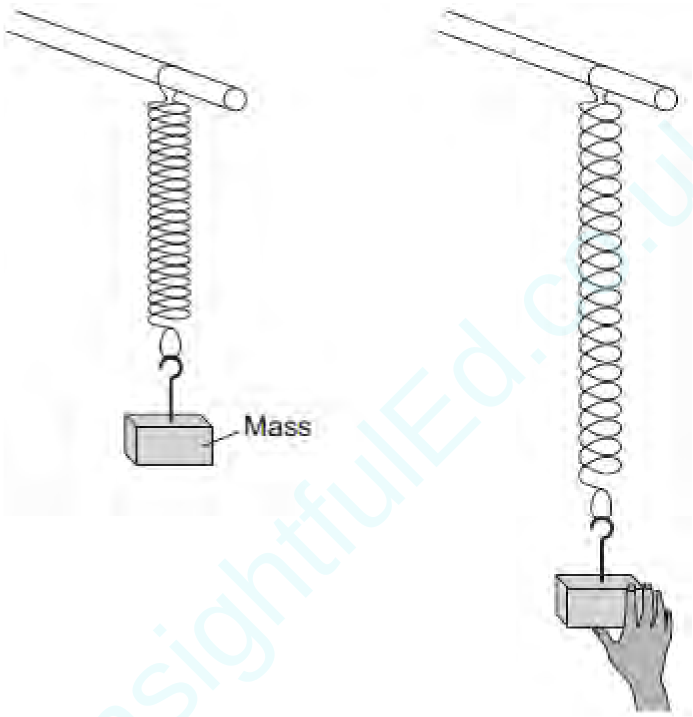
www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

(c) In a third investigation the student:

- suspended a 100 g mass from a spring
- pulled the mass down as shown in **Figure 2**
- released the mass so that it oscillated up and down
- measured the time for 10 complete oscillations of the mass
- repeated for masses of 200 g, 300 g and 400 g.

Figure 2



www.InsightfulEd.co.uk

Her results are shown in **Table 2**.

Table 2

	Time for 10 complete oscillations in seconds			
Mass in g	**Test 1**	**Test 2**	**Test 3**	**Mean**
100	4.34	5.20	4.32	4.6
200	5.93	5.99	5.86	5.9
300	7.01	7.12	7.08	7.1
400	8.23	8.22	8.25	8.2

(i) Before the mass is released, the spring stores energy.

What type of energy does the spring store?

INSIGHTFUL EDUCATION

Tick (✓) **one** box.

	Tick (✓)
Elastic potential energy	
Gravitational potential energy	
Kinetic energy	

(1)

(ii) The value of time for the 100 g mass in **Test 2** is anomalous.

Suggest **two** likely causes of this anomalous result.

Tick (✓) **two** boxes.

	Tick (✓)
Misread stopwatch	
Pulled the mass down too far	
Timed half oscillations, not complete oscillations	
Timed too few complete oscillations	
Timed too many complete oscillations	

(2)

(iii) Calculate the correct mean value of time for the 100 g mass in **Table 2**.

____

____

Mean value = ____________________ s

(1)

(iv) Although the raw data in **Table 2** is given to 3 significant figures, the mean values are correctly given to 2 significant figures.

Suggest why.

____

____

____

____

(2)

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

(v) The student wanted to plot her results on a graph. She thought that four sets of results were not enough.

What extra equipment would she need to get more results?

___

___

___

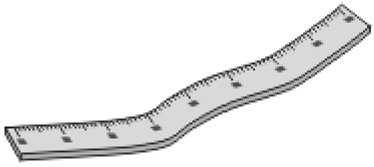
___

(2)

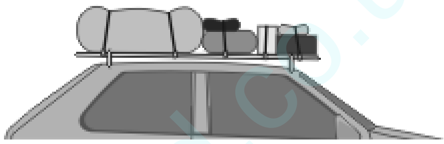
(Total 17 marks)

Q6.

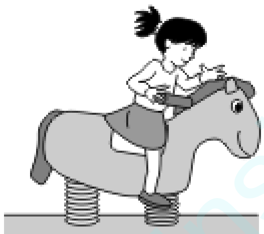
(a) The pictures show four objects. Each object has had its shape changed.



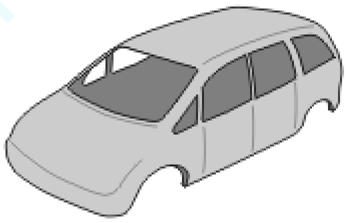
Bent metal ruler
A



Stretched bungee cords
B



Springs on a playground ride
C



Moulded plastic model car body
D

Which of the objects are storing elastic potential energy?

___

Explain the reason for your choice or choices.

___

___

___

___

___

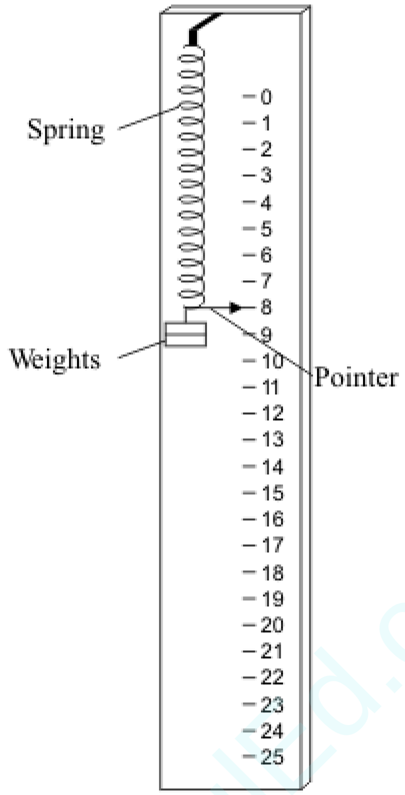
___

(3)

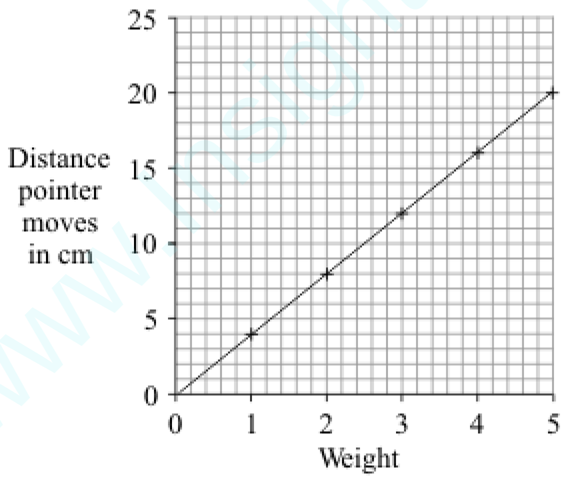
www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

(b) A student makes a simple spring balance. To make a scale, the student uses a range of weights. Each weight is put onto the spring and the position of the pointer marked



The graph below shows how increasing the weight made the pointer move further.



www.insightfuled.co.uk

(i) Which **one** of the following is the unit of weight?.

Draw a ring around your answer.

joule **kilogram** **newton** **watt**

(1)

(ii) What range of weights did the student use?

____

(1)

INSIGHTFUL EDUCATION

(iii) How far does the pointer move when 4 units of weight are on the spring?

___

(1)

(iv) The student ties a stone to the spring. The spring stretches 10 cm.

What is the weight of the stone?

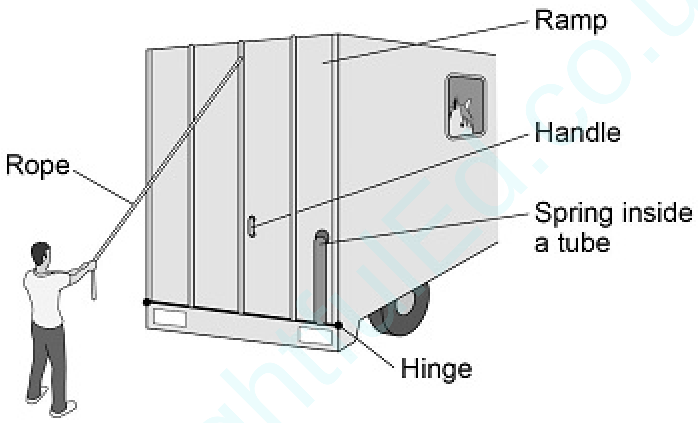
___

(1)
(Total 7 marks)

Q7.

Figure 1 shows the back of a lorry. The lorry is used to carry horses.

Figure 1



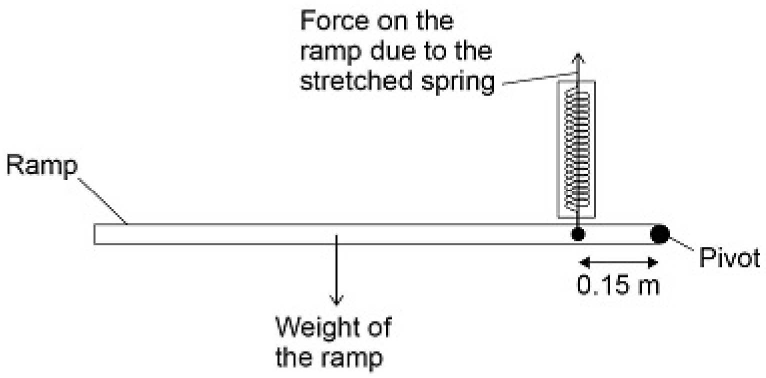
The ramp is lowered by pulling on the rope or by pulling on the handle.

The hinge acts as a pivot.

When the ramp is lowered, work is done to stretch a spring on the side of the ramp. Elastic potential energy is stored in the stretched spring.

Figure 2 shows the ramp part way down in a balanced horizontal position.

Figure 2



www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

(b) With the ramp horizontal:

the moment caused by the weight of the ramp = 924 Nm

the spring is stretched by 0.250 m

Calculate the elastic potential energy stored in the stretched spring.

Use data from **Figure 2**.

Elastic potential energy = ____________________ J

(6)

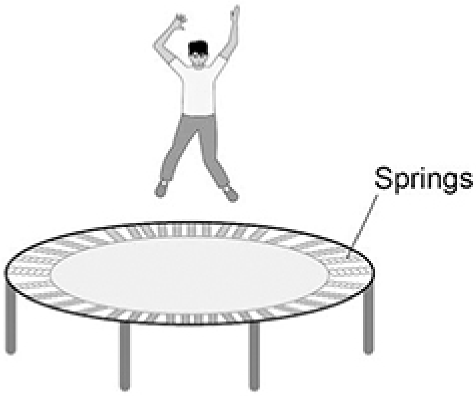
(Total 8 marks)

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

Q8.

The figure shows a boy bouncing on a trampoline.



(a) The boy falls from the position in the figure above towards the trampoline.

Complete the sentences.

Choose answers from the box.

chemical	**elastic potential**	**gravitational potential**
kinetic	**nuclear**	

As the boy falls, there is a decrease in his _______________ energy.

As the boy falls, there is an increase in his ______________ energy.

(2)

(b) As the boy lands on the trampoline, each spring stretches 0.015 m.

spring constant of each spring = 120 000 N/m

Calculate the energy stored by each spring.

Use the equation:

elastic potential energy = 0.5 × spring constant × $(\text{extension})^2$

____

____

____

Elastic potential energy = _______________ J

(2)

(c) There are 40 springs on the trampoline.

Calculate the total energy stored by the 40 springs when each spring is stretched by

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

0.015 m.

Use your answer from part (b)

____

____

Total energy stored = _______________ J

(1)

(d) The kinetic energy of the boy as he lands on the trampoline is 600 J.

The maximum kinetic energy of the boy after he bounces is 45% of his kinetic energy as he lands.

Calculate the maximum kinetic energy of the boy after he bounces.

____

____

____

Maximum kinetic energy = _______________ J

(2)

(e) Why is the kinetic energy of the boy after he bounces less than his kinetic energy as he lands?

Tick (✓) **one** box.

Energy is not conserved.	☐
Energy is transferred to the surroundings.	☐
The springs transfer energy to the boy.	☐

(1)

(Total 8 marks)

www.InsightfulEd.co.uk

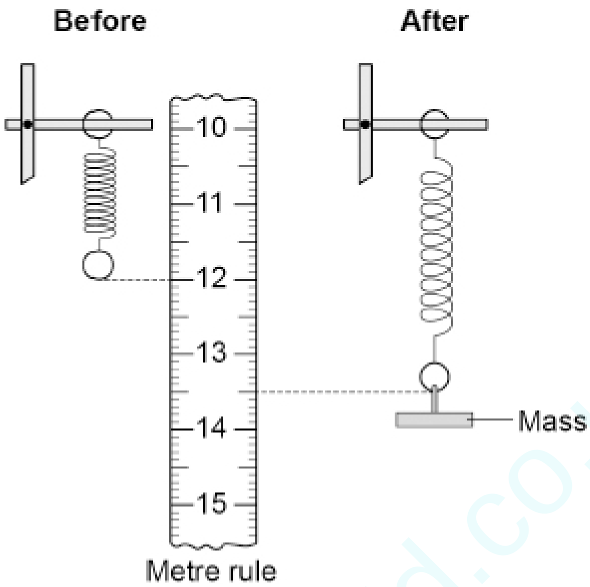
INSIGHTFUL EDUCATION

Q9.

A student carried out an investigation to determine the spring constant of a spring.

Figure 1 shows the spring before and after a mass was hung from the end of the spring.

Figure 1



(a) What is the extension of the spring in **Figure 1**?

Tick (✓) **one** box.

1.5 cm ☐

3.5 cm ☐

13.5 cm ☐

(1)

(b) Give **one** safety precaution the student should have taken during this investigation.

____

____

(1)

(d) The weight of the mass applies a force to the spring.

The student added more masses and recorded the extension of the spring.

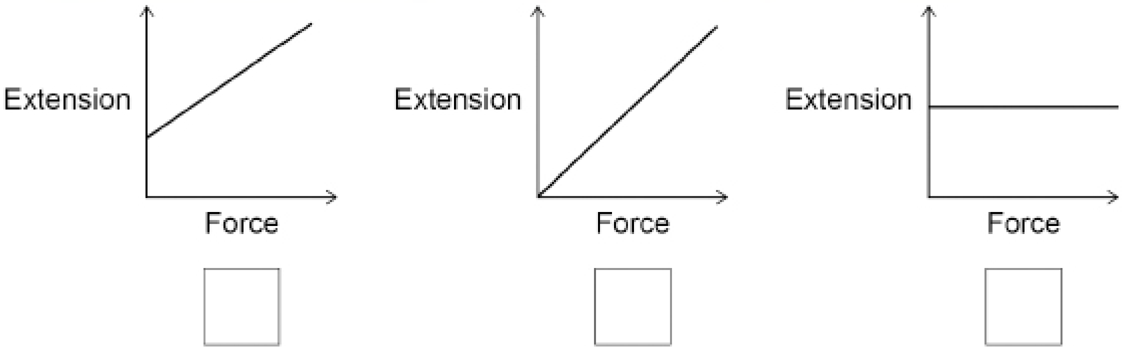
Which graph in **Figure 2** shows the relationship between the force applied to the spring and the extension of the spring?

Tick (✓) **one** box.

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

Figure 2



(1)

(e) A force of 2.0 N was applied to a different spring.

The extension of the spring was 0.080 m.

Calculate the spring constant of the spring.

Use the equation:

$$\text{spring constant} = \frac{\text{force}}{\text{extension}}$$

____

____

____

Spring constant = ____________________ N/m

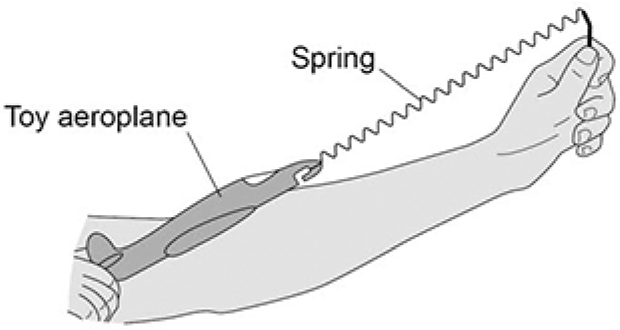
(2)

www.InsightfulEd.co.uk

Q10.

The figure below shows a student launching a toy aeroplane.

To launch the aeroplane, the student pulls on it to stretch the spring and then releases it.



(a) (HIGH DIFFICULTY) Just before the toy aeroplane is released, the spring has an extension of 0.12 m.

mass of aeroplane = 0.020 kg

spring constant of the spring = 50 N/m

INSIGHTFUL EDUCATION

Calculate the maximum speed of the toy aeroplane just after it is launched.

Use the Physics Equations Sheet.

Give the unit.

____

Speed = ___________ Unit ___________

(6)

(b) Complete the sentence.

As the aeroplane moves upwards through the air there is a decrease

in the ______________________ energy of the aeroplane.

(1)

(c) Give **one** factor which would increase the distance the toy aeroplane travels horizontally before hitting the ground.

____

(1)

(Total 8 marks)

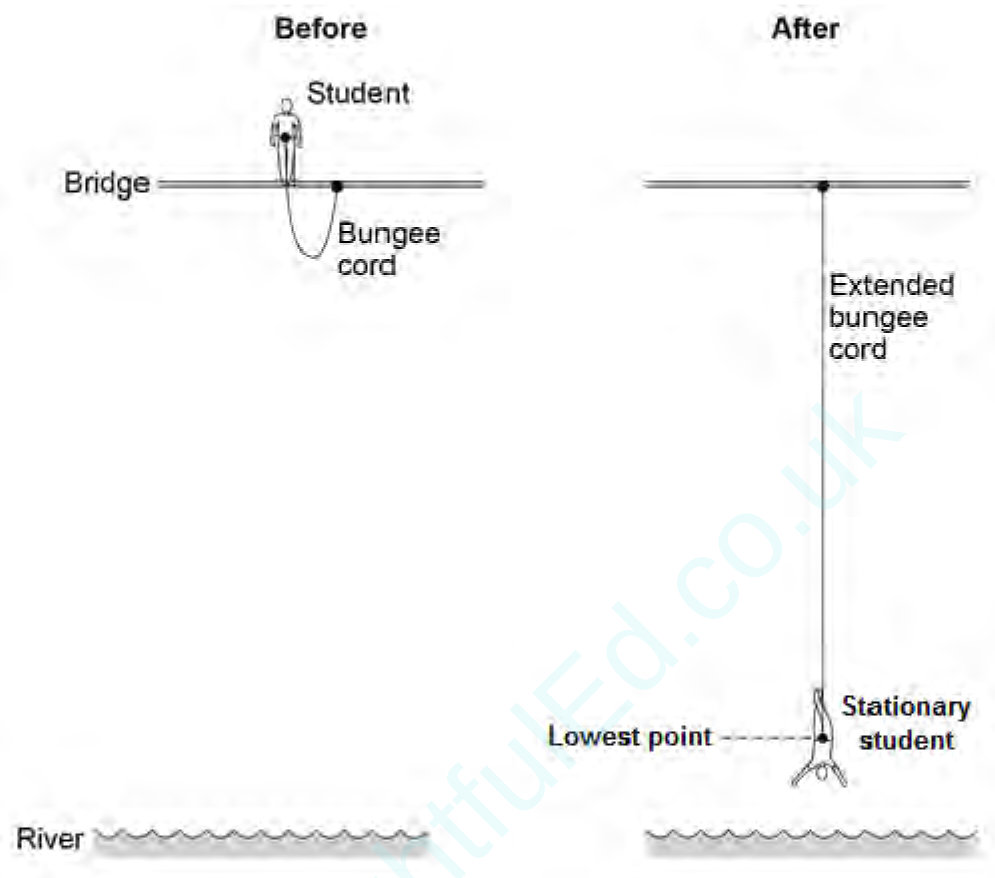
www.insightfulEd.co.uk

INSIGHTFUL EDUCATION

Q11.

The image below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.



(a) For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

1. ____

____

2. ____

____

(2)

(b) The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential **gravitational potential** **kinetic** **sound** **thermal**

Before the student jumps from the bridge he has a store of

www.insightfulEd.co.uk

INSIGHTFUL EDUCATION

_____________________ energy.

When he is falling, the student's store of _____________________

energy increases.

When the bungee cord is stretched, the cord stores energy as

_____________________ energy.

(3)

(c) At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N / m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

____

____

____

Energy = __________________________ J

(2)

(Total 7 marks)

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

Mark schemes

Q1.

(a) spring may become permanently extended

ignore reference to limit of proportionality

allow the harness / spring / chain may break

or

extension of the spring may be too great (so the baby's feet are always on the floor)

ignore baby may be injured / harmed / may hit doorframe

1

(b) (in position **A**) the baby has gravitational potential energy

allow E_p for gravitational potential energy

1

(as the baby moves down this) is transferred to kinetic energy

allow E_k for kinetic energy

(of the baby) and / then elastic potential energy (of the spring)

allow E_e for elastic potential energy

1

(in position **B**) all the energy is elastic potential energy

ignore energy dissipated to the surroundings

1

(c) e = 0.080 (m)

1

4.0 = ½ × k × 0.080^2

allow a correct substitution using an incorrectly / not converted value of e

1

$$k = \frac{4.0}{(0.5 \times 0.080^2)}$$

allow a correct rearrangement using an incorrectly / not converted value of e

1

k = 1250 (N/m)

allow an answer consistent with their value of e

1

[8]

www.insightfulEd.co.uk

Q2.

(a)

Energy store	Less than	The same	More than

INSIGHTFUL EDUCATION

	at A	as at A	at A
The student's gravitational potential energy	✓		
The student's kinetic energy			✓
The bungee cord's elastic potential energy			✓

additional tick in a row negates the mark for that row

3

(b) $E_e = 0.5 \times 78.4 \times 25^2$

1

$E_e = 24\ 500$ (J)

1

(c) greatest spring constant

allow needs largest force (per metre) to stretch the cord

1

(d) A

1

greatest extension before snapping

MP2 dependent on scoring MP1

1

[8]

Q3.

(a) **F** 50 cm on first part of graph

*tolerance + **or** – 3cm*

1

(b) **S** at the far right

credit anywhere to right of last trough

1

(c) **M** on any two tops of peaks **or** bottoms of troughs

*both are required for the mark M needs to be central to the trough **or** peak, except if F is in the way in one case*

1

[3]

Q4.

(a) will return to its original shape/length

1

when the force is removed

allow (when) the child gets off

www.insightfulEd.co.uk

INSIGHTFUL EDUCATION

the second mark is dependent on scoring the first mark

1

(b) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- set up a clamp stand with a clamp
- hang the spring from the clamp
- use a second clamp and boss to fix a (half) metre rule alongside the spring
- record the ruler reading that is level with the bottom of the spring
- hang a 1 N / a known weight from the bottom of the spring
- record the new position of the bottom of the spring
- calculate the extension of the spring
- measure the extension of the spring
- add further weights to the spring so the force increases 1 N at a time up to 5 N
- for each new force record the position of the bottom of the spring and calculate / measure the extension

<u>Risk Assessment</u>

Hazard: Clamp (stand, boss and masses) might fall off desk
Risk: injury to feet
Precaution: Use clamp to fix apparatus to the bench **or**
Ensure that the slotted masses hang over the base/foot of the stand **or**
Ensure that the boss is screwed tightly into the stand and clamp **or**
Put (heavy) masses on the base/foot of the stand **or** Stand up so that you can move out of the way

Hazard: Spring could break / come loose
Risk: damage eye
Precaution: Wear safety goggles

If a risk assessment / hazard is not given, the answer can still reach level 3, but not full marks.

Full marks may be awarded for alternative feasible methods.

(c) force = spring constant × extension

1

(d) 5.00 0.125

allow any correct pair of values from the graph

www.insightfuled.co.uk

INSIGHTFUL EDUCATION

1

$k = \frac{5.00}{0.125}$

allow a misread value(s) from the graph

1

k = 40 (N/m)

allow a correct calculation using their incorrect value(s)

1

(e) the line is straight

allow the line does not curve

allow a constant gradient

1

and passes through the origin

1

(f) e = 0.20 m

1

$E_e = 0.5 \times 13 \times 0.20^2$

allow an incorrectly / not converted value of e

1

E_e = 0.26 (J)

use of two incorrectly/not converted values scores a maximum of 1 mark

1

[17]

Q5.

(a) (i) any **two** from:

- length of coils increased
- coils have tilted
- length of loop(s) increased
- increased gap between coils
- *spring has stretched / got longer*
- *spring has got thinner*

2

(ii) remove mass

accept remove force / weight

1

observe if the spring returns to its original length / shape *(then* it is behaving elastically)

1

(b) (i) 8.0 (cm)

1

extension is directly proportional to force *(up to 4 N)*

for every 1.0 N extension increases by 4.0 cm (up to 4 N)

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

evidence of processing figures eg 8.0 *cm* is half way between 4.0 *cm* and 12.0 *cm*

1

allow spring constant (k) goes from to $\frac{1}{4}$ to $\frac{5}{22}$

1

(ii) any value greater than 4.0 N and less than or equal to 5.0 N

1

the increase in extension is greater than 4 cm per 1.0 N (of force) added

dependent on first mark

1

(c) (i) elastic potential energy

1

(ii) misread stopwatch

1

timed too many complete oscillations

1

(iii) 4.3 (s)

accept 4.33 (s)

1

(iv) stopwatch reads to 0.01 s

1

reaction time is about 0.2 s
or
reaction time is less precise than stopwatch

1

(v) use more masses

1

smaller masses eg 50 g

not exceeding limit of proportionality

1

[17]

www.InsightfulEd.co.uk

Q6.

(a) **B** or bungee cords

1

C or springs or playground ride

each additional answer loses ***1*** *mark minimum mark zero*

1

will go back to original shape/size

1

(b) (i) newton

1

(ii) 0 – 5 (N) or 5

INSIGHTFUL EDUCATION

accept1 – 5 (N)
*do **not** accept 4*
1

(iii) 16 (cm)
1

(iv) 2.5 (N)
accept answer between 2.4 and 2.6 inclusive
1

[7]

Q7.

(b)

*an answer of 770 scores **6** marks*

924 = F × 0.15
1

F = 6160 (N)
allow use of E = ½ F e instead of k = F ÷ e and E = ½ × k × e²
1

6160 = k × 0.25
allow their calculated F = k × 0.25
1

$k = \frac{6160}{0.25}$
or
k = 24640 (N/m)
allow a value for k calculated using their calculated F
1

$E = \frac{½ \times 6160 \times 0.25 \times 0.25}{0.25}$
allow E = ½ × their calc. k × 0.25²
1

E = 770 (J)
allow an answer consistent with their calculated k
1

Q8.

(a) gravitational potential
1

kinetic
1

this order only

(b) E_e = 0.5 × 120 000 × 0.015²

www.insightfulEd.co.uk

INSIGHTFUL EDUCATION

1

E_e = 13.5 (J) 1

(c) E = 540 (J)

allow their answer from part ***(b)*** × *40* 1

(d) E_k = 0.45 × 600 1

E_k = 270 (J) 1

(e) energy is transferred to the surroundings 1

[8]

Q9.

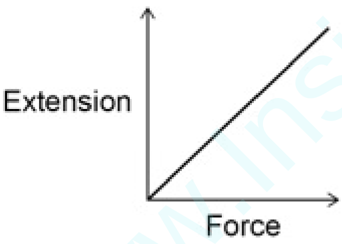
(a) 1.5 cm 1

(b) any **one** from:

- clamp the stand to the desk
- wear safety goggles / glasses
- stand up / away from apparatus
- limit the total mass used
- have masses over the base of the stand

1

(d)



1

(e) $k = \dfrac{2.0}{0.080}$ 1

k = 25 (N/m) 1

[7]

Q10.

(a) $E_e = 0.5 \times 50 \times 0.12^2$ 1

E_e = 0.36 (J) 1

$0.36 = 0.5 \times 0.020 \times v^2$

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

allow a correct substitution of their calculated value of E_e

1

$$v^2 = \frac{0.36}{0.5 \times 0.020}$$

allow a correct rearrangement of their calculated value of E_e

or

$v^2 = 36$

1

speed = 6.0

allow an answer consistent with their calculated value of E_e

1

m/s

or

metres/second

1

Alternative approach:
(F = ke)
(F = 50 × 0.12)
(maximum) F = 6.0 (N) (1)

(F = ma)
(6.0 = 0.020 × a)
(maximum) a = 300 (m/s²) (1)
mean a = 150 (m/s²) (1)
($v^2 - u^2 = 2as$)
$v^2 = 2 \times 150 \times 0.12$ (1)
or
$v^2 = 36$
v = 6.0 (1)
m/s (1)
or
metres/second

(b) kinetic

1

(c) increasing the extension of the spring
or
more elastic potential energy
or
increase the angle of release (to the horizontal by a small amount)

allow other factors that would increase the horizontal distance travelled eg a tail-wind

ignore factors without a change specified e.g. extension unqualified would not score

ignore changing the spring or changes to the toy aeroplane

1

www.InsightfulEd.co.uk

INSIGHTFUL EDUCATION

[8]

Q11.

(a) any **two** from:

- bungee rope may snap
- rope may extend too much
- student may land in the river

2

(b) gravitational potential

correct order only

1

kinetic

1

elastic potential

1

(c) $\frac{1}{2} \times 40 \times 35^2$

1

24 500 (J)

accept 25 000 (J) (2 significant figures)

1

*allow 24 500 (J) with no working shown for **2** marks*

[7]

www.InsightfulEd.co.uk