

PHYSICS



EXAM QUESTION PACK

P2.3 FORCES IN ACTION

SCORE

/167

PERCENTAGE

%

STEMUP

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Gateway Physics A (9-1)

Forces in action

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname								
Centre number						Candidate number				

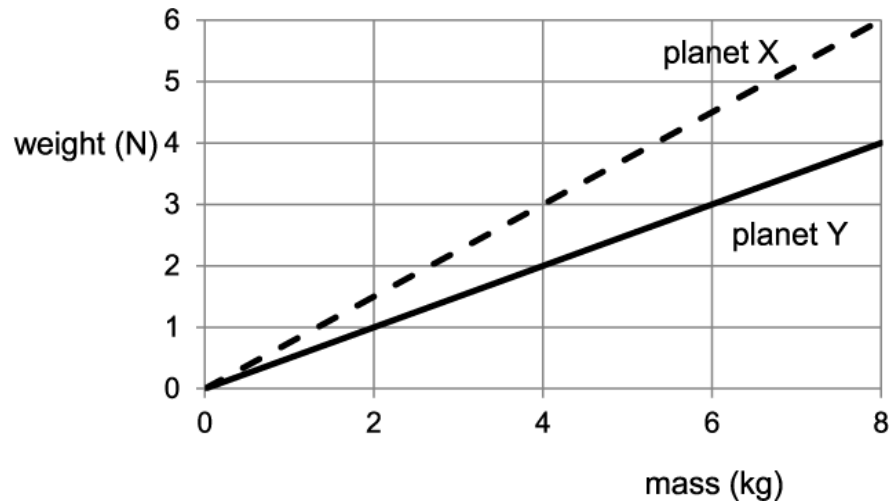
INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **167**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 The graph shows the relationship between mass and weight on two different planets.



The weight of an object on planet X is 3 N.

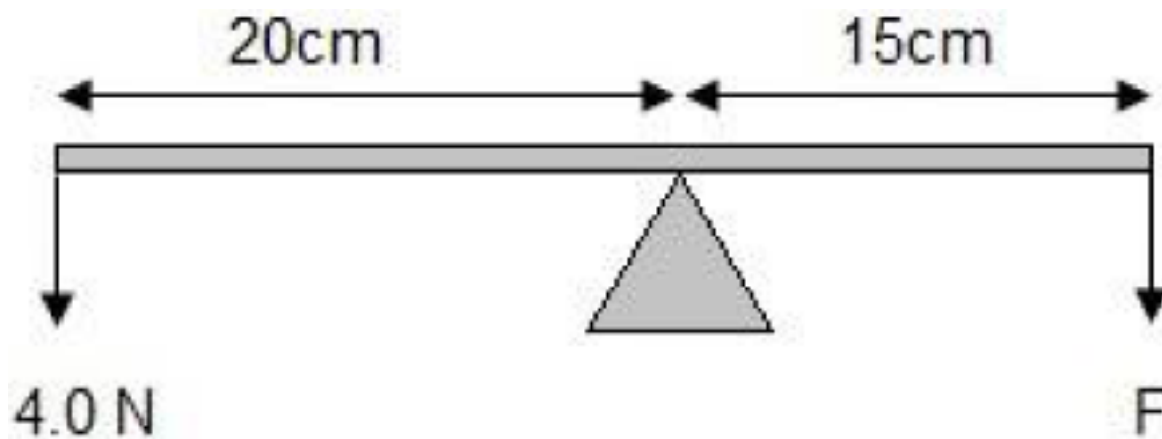
What is the weight of the same object on planet Y?

- A 1.5 N
- B 2.0 N
- C 4.0 N
- D 6.0 N

Your answer

[1]

2 A see-saw is in equilibrium.



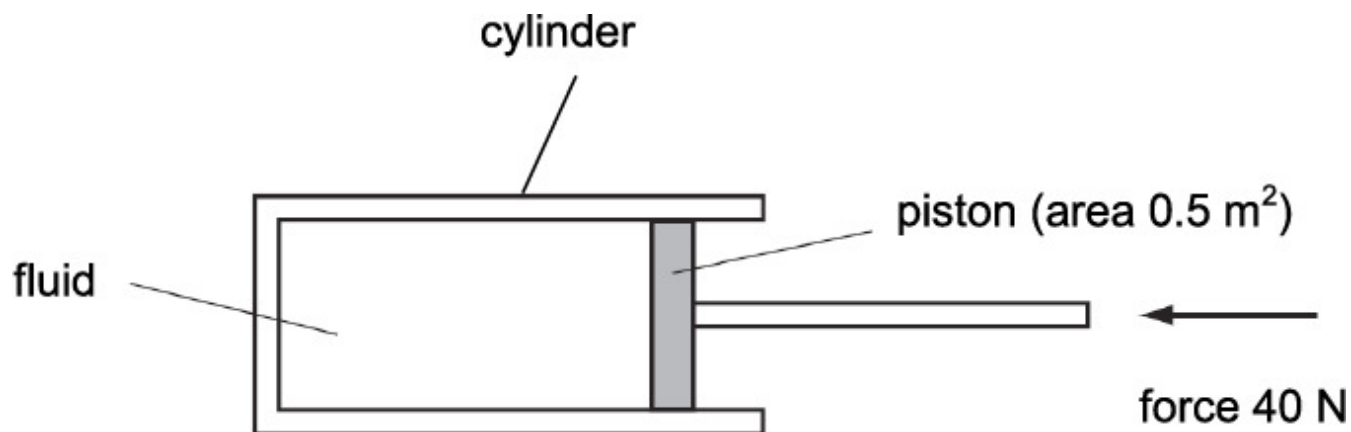
What force is needed for the see-saw to be in equilibrium?

- A 3.0 N
- B 3.5 N
- C 5.0 N
- D 5.3 N

Your answer

[1]

- 3 A piston is pushed in a cylinder containing a fluid.



If **pressure = force ÷ area**, what is the pressure exerted on the fluid?

- A 20 Pa
- B 80 Pa
- C 160 Pa
- D 200 Pa

Your answer

[1]

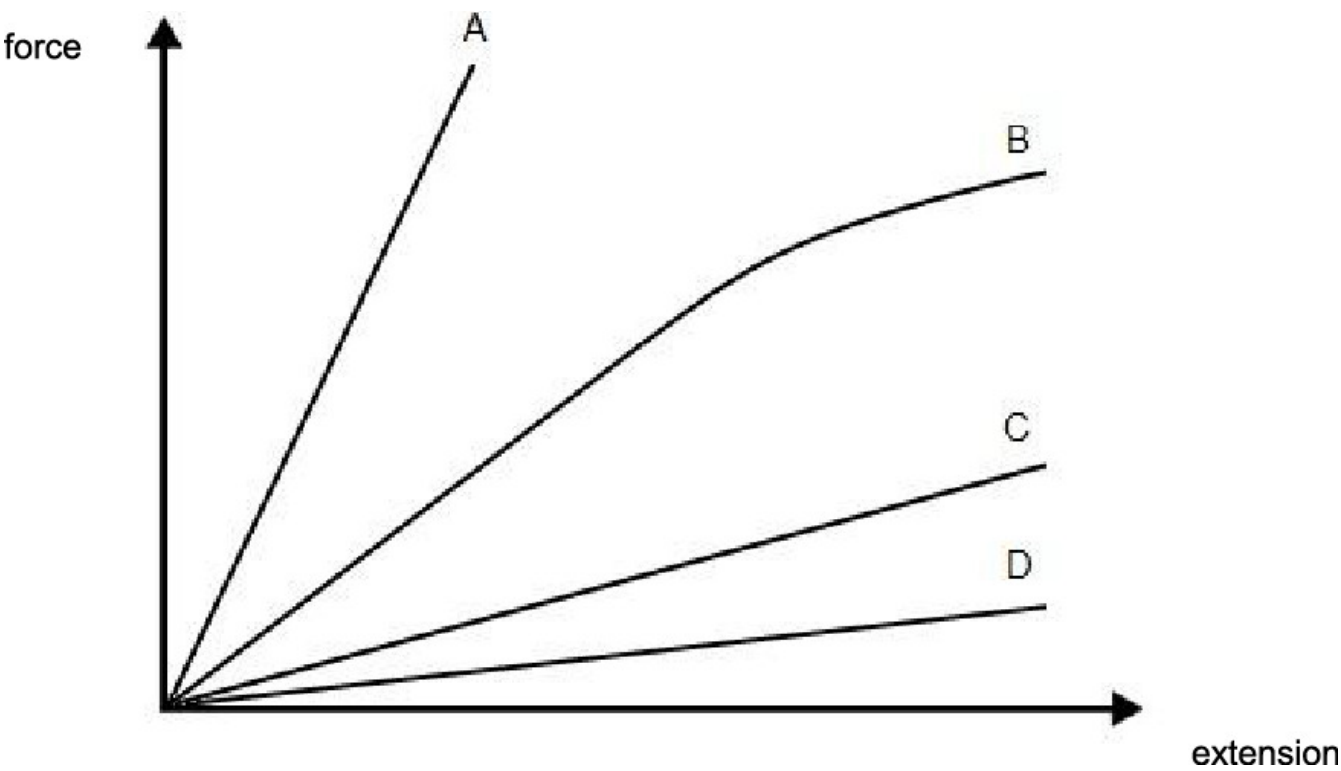
- 4 What is the **minimum** number of forces that are required to compress a spring?

- A 1
- B 2
- C 3
- D 4

Your answer

[1]

6(a) The extension of four different springs is shown in the graph.



Explain which of the springs A, B, C or D has the highest spring constant?

-----[2]

(b) Explain why the line for spring B has a different shape to the others.

-----[2]

(c)

- (i) A spring has a spring constant of 27 N/m.

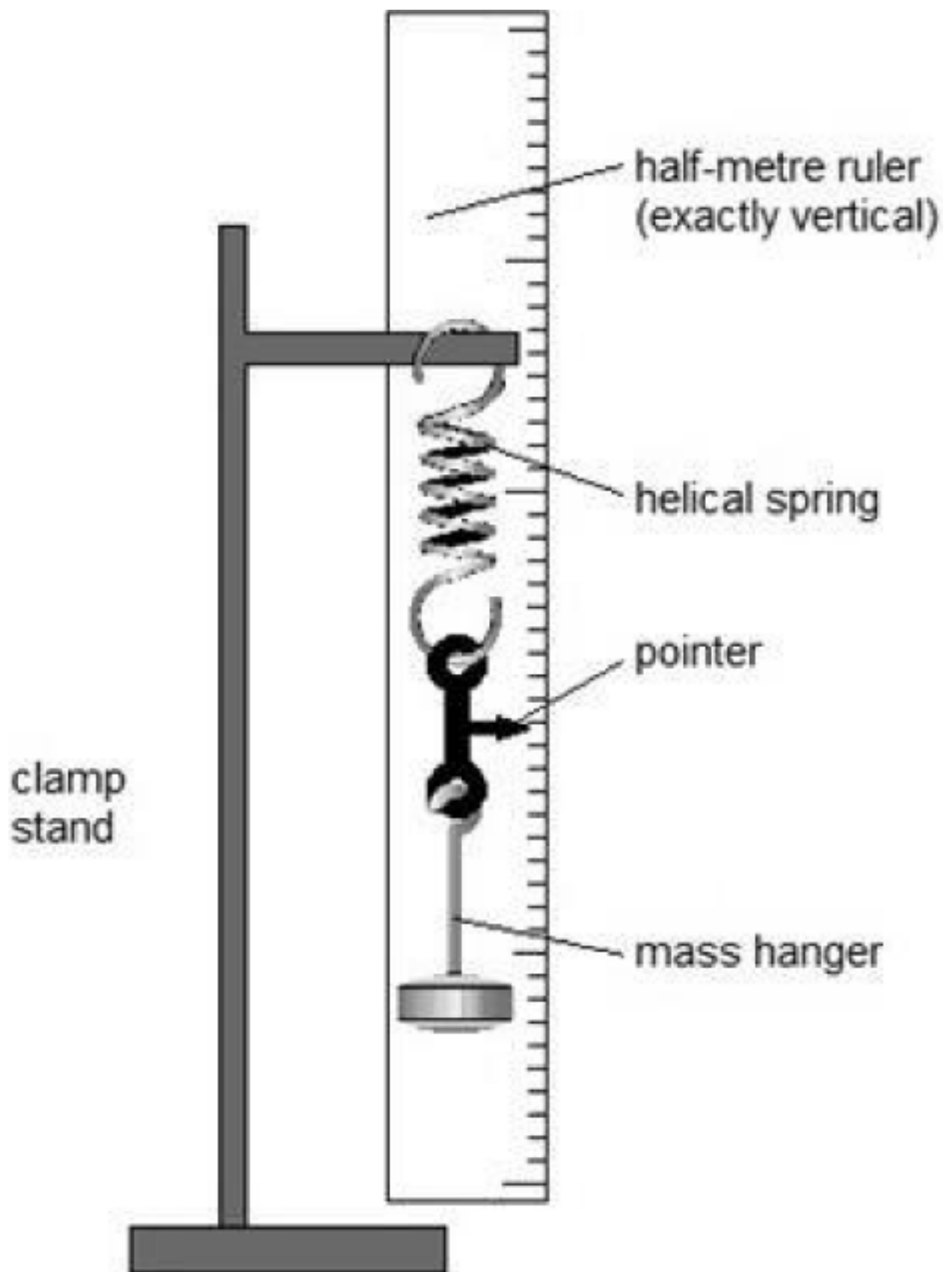
For an extension of 25 cm, calculate the energy transferred in stretching.

Use the formula: $\text{energy transferred} = 0.5 \times \text{spring constant} \times \text{extension}^2$.

answer: ----- J

[2]

- (ii) A student set up the apparatus shown in the diagram.



Describe how they could use this apparatus to collect data to draw a force / extension graph for this spring.

[4]

(iii) The above spring has a spring constant of 30 N/m, this is replaced by a spring with a spring constant of 10 N/m.

What changes will the student have to make to this method to investigate this spring?

[2]

7 A boy kicks a football.



The football has a mass of 400 g.

What is the potential energy of the football when it is 0.8 m above the ground?

Use the constant: gravitational field strength (g) = 10 N/kg.

A 0.032 J

B 3.2 J

C 320 J

D 3 200 J

Your answer

[1]

8(a) A rocket carrying a vehicle called the Mars Rover was sent to Mars.



The Mars Rover has a mass of 185 kg.

The gravitational field strength (g) on Mars is 3.75 N/kg.

Calculate the weight of the Rover vehicle on Mars.

Show your working and give your answer to 3 significant figures.

State the unit for weight.

answer: _____ unit _____ [5]

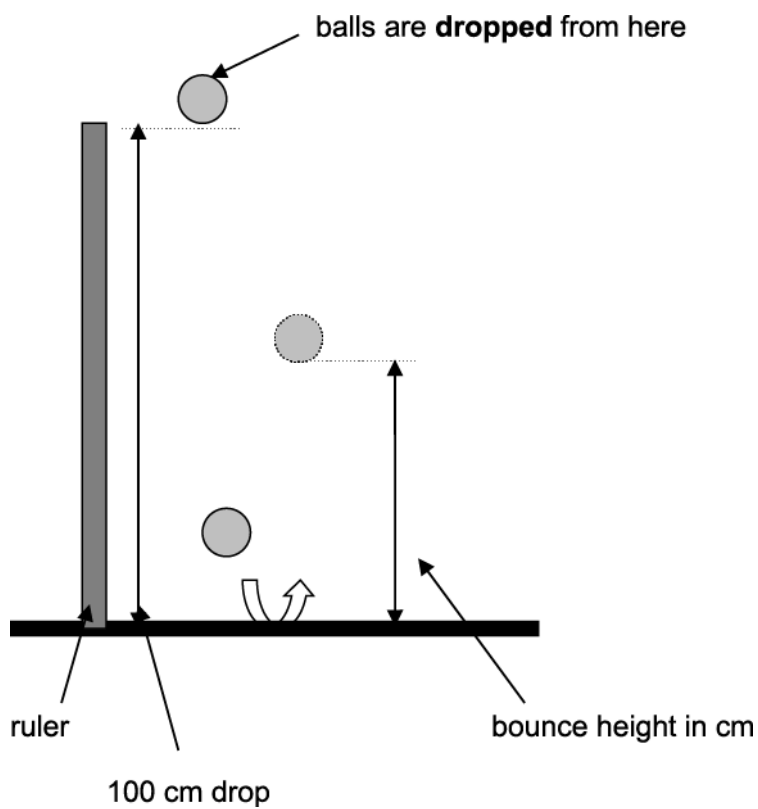
(b) Why did the Mars Rover weigh more on Earth than on Mars?

----- [1]

9(a) Kate investigates how well different balls bounce.

She drops different balls from the same height and measures the height the balls bounce.

She repeats the experiment 3 times for each ball.



Her results are shown in the table.

Ball	Drop height (cm)	1 st reading bounce height (cm)	2 nd reading bounce height (cm)	3 rd reading bounce height (cm)	Mean bounce height (cm)
Red	100	75	77	73	75
Blue	100	61	62	60	61
Green	100	60	31	58	
White	100	84	86	85	85
Yellow	100	26	24		26

Calculate the **mean** bounce height for the **green** ball.

[1]

answer:----- cm

(b) Kate missed one result for the **yellow** ball.

Calculate the **missing** result for the **yellow** ball.

answer: ----- cm [1]

(c) Evaluate the reliability of the results

Suggest how she could have improved her experiment.

----- [3]

(d)

(i) Kate suggests that 15% of the ball's initial energy was not transferred usefully. Use calculations to show that this is correct and suggest where the energy was transferred to.

----- [2]

(ii) How could the efficiency of the ball be improved?

----- [1]

10 A boy kicks a football.



The football has a mass of 400 g.

What is the potential energy of the football when it is 0.8 m above the ground?

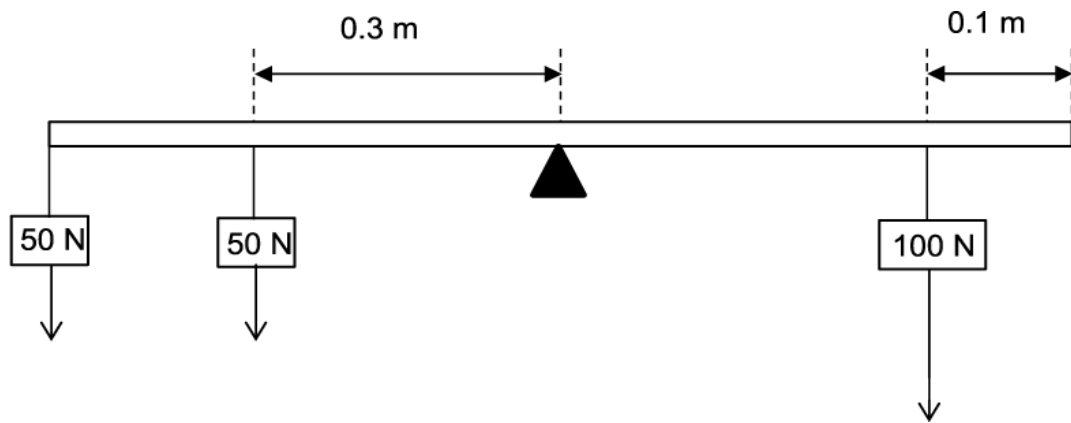
Use the constant: gravitational field strength (g) = 10 N/kg.

- A 0.032 J
- B 3.2 J
- C 320 J
- D 3 200 J

Your answer

[1]

11 A uniform 1.0 m rod is pivoted at its centre.



The rod is in equilibrium.

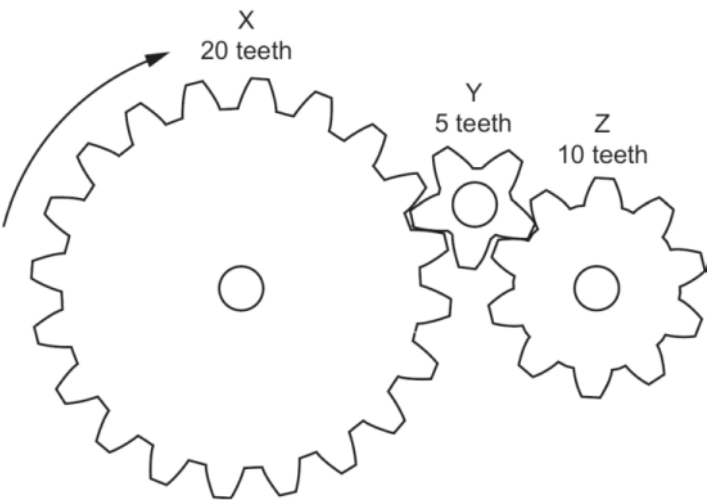
What is the value of the anti-clockwise moment about the pivot?

- A 10 Nm
- B 15 Nm
- C 40 Nm
- D 100 Nm

Your answer

[1]

12 The diagram shows 3 gears.



Gear X is rotated clockwise at 1.0 rotations per second.

Which row is the correct description of the movement of gear Z?

	direction of rotation	rotations per second
A	anticlockwise	0.5
B	anticlockwise	2.0
C	clockwise	0.5
D	clockwise	2.0

Your answer ☐

[1]

13 How much work is done on a spring, of spring constant 16 N/m, when it is stretched 50 cm?

- A 2.0 J
- B 8.0 J
- C 12.5 J
- D 25.0 J

Your answer ☐

[1]

14 The seat belt exerts a force on the passenger when a car is stopping.

This force causes a change in momentum of the passenger.

Look at the table for four different passengers when their car stops.

Passenger	Change in momentum of passenger in kg m/s	Passenger stopping time in seconds
A	1440	4
B	1224	2
C	1200	3
D	1000	1

Which passenger experiences the greatest force from their seat belt?

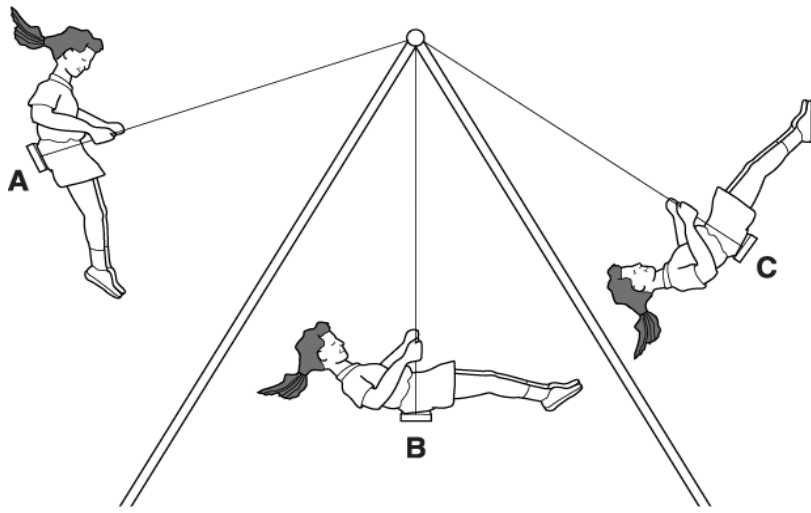
Choose from: A B C D

answer _____

[1]

15 Julie uses the swing.

Look at the diagram showing different positions during the swing.



(i) Which position shows where Julie has the greatest kinetic energy?

Choose from: A B C

answer _____

[1]

(ii) Which position shows where Julie has the greatest gravitational potential energy?

Choose from: A B C

answer _____

[1]

16 A rocket was sent to Mars.

The rocket carried a vehicle called the Mars Rover.



The Mars Rover has a mass of 185 kg.

Its wheels are designed to carry a total weight of up to 1800 N.

The gravitational field strength (g) on Mars is 3.8 N/kg.

This means a mass of 1 kg on Mars weighs 3.8 N.

(i) Calculate the weight of the Rover vehicle on Mars.

answer _____ N [2]

(ii) Look at the table showing how gravitational field strength varies.

Place	Gravitational field strength in N/kg
Moon	1.6
Earth	10.0
Mars	3.8

Scientists are happy for the Rover to be used on the Moon or Mars.

They are very careful when using the Rover on Earth.

Use the data and information about the Rover to explain why.

----- [2]

17

- (i) A rocket is in a stable orbit.

To keep the rocket in this orbit its speed needs to stay at 8000 m/s.

Suggest, by using ideas about gravitational and centripetal forces, why this speed needs to be maintained to keep it in this stable orbit.

----- [3]

- (ii) The rocket re-enters the Earth's atmosphere safely.

In the final part of the descent its speed reduces steadily from 2000 m/s to 120 m/s just before touchdown. This takes place over a distance of 5×10^5 m.

Calculate the average **deceleration** over this distance.

answer ----- m/s²

[3]

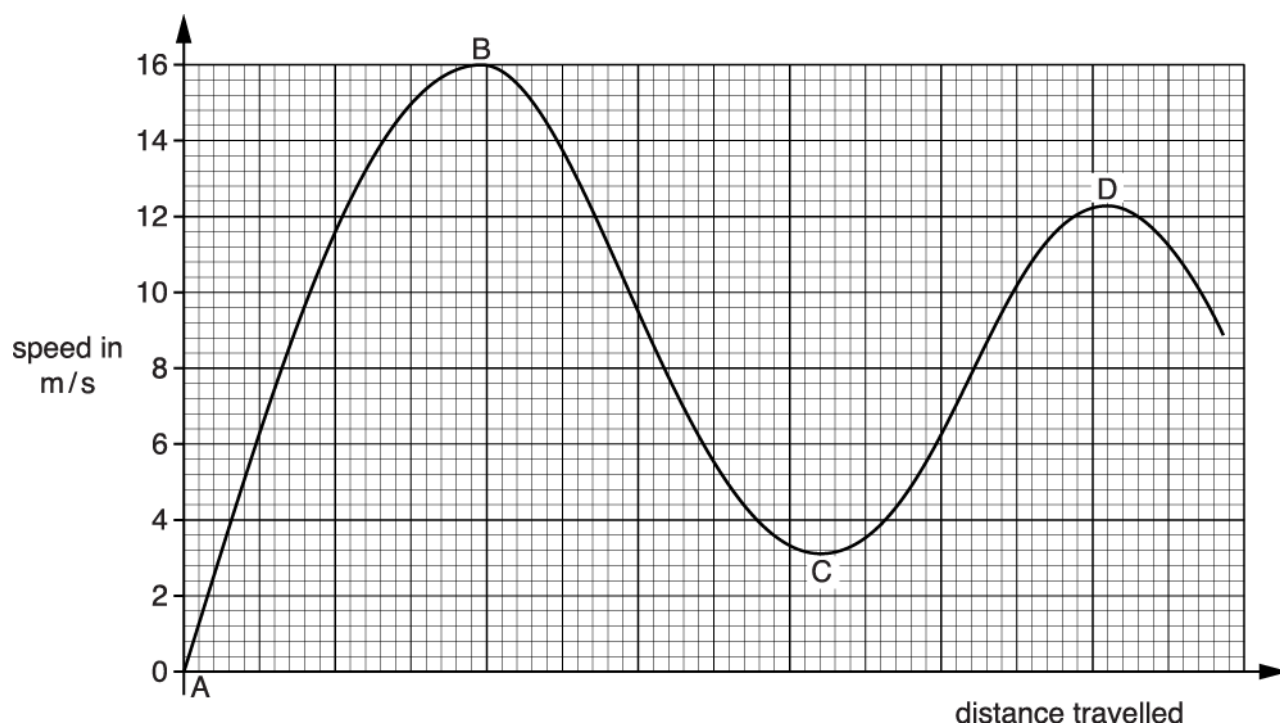
18 This question is about kinetic and gravitational potential energy.

Look at the graph.

It shows how the speed of a roller coaster car changes with the distance travelled along part of the track.

The roller coaster car starts from rest at the top of the track at A.

The car and its passengers have a total mass of 400 kg.



Describe how the kinetic energy and the gravitational potential energy of the car change in sections AB and BC of the journey, and calculate the difference in height of the roller coaster between A and B assuming no energy is lost.

The acceleration due to gravity is 10 m/s^2 .



The quality of written communication will be assessed in your answer to this question.

[6]

19(a) Emma drops a rock from the top of a cliff.

The rock has a mass of 0.5 kg.

As the rock falls it loses potential energy and gains kinetic energy.

The rock is travelling at a speed of 15 m / s just before it hits the ground.

Calculate the distance the rock falls.

Take the value of g to be 10 N / kg.

Ignore the effect of air resistance.

answer answer _____ metres

[3]

(b) Emma drops another rock.

This rock has a mass of 1.0 kg.

The rock hits the ground at the same speed.

Explain why.

[1]

20 A rocket was sent to Mars.

The rocket carried a vehicle called the Mars Rover.



The Mars Rover has a mass of 185 kg.

Its wheels are designed to carry a total weight of up to 1800 N.

The gravitational field strength (g) on Mars is 3.8 N / kg.

This means a mass of 1 kg on Mars weighs 3.8 N.

(i) Calculate the weight of the Rover vehicle on Mars.

answer ----- N [2]

(ii) Look at the table showing how gravitational field strength varies.

Place	Gravitational field strength in N / kg
Moon	1.6
Earth	10.0
Mars	3.8

Scientists are happy for the Rover to be used on the Moon or Mars.

They are very careful when using the Rover on Earth.

Use the data and information about the Rover to explain why.

[2]

21 Hossein is a weightlifter.

His best lift in training is a bar with a mass of 250kg.

He does 5000 J of work on the bar with a mass of 250kg when he lifts it.

The gravitational field strength (g) on Earth is 10 N/kg.



Calculate the weight of this 250kg mass, and how high Hossein lifts the bar.

weight = _____ N

height lifted = _____ m

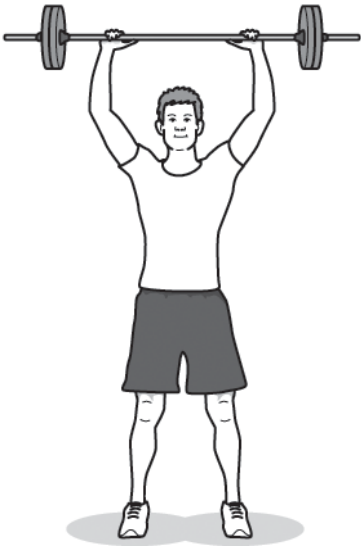
[3]

22 Hossein is a weightlifter.

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He does 5000 J of work on the bar with a mass of 250kg when he lifts it.

The gravitational field strength (g) on Earth is 10 N/kg.



Calculate the weight of this 250kg mass, and how high Hossein lifts the bar.

weight = ----- N

height lifted = ----- m

[3]

23 Look at the table below.

It shows different stones dropped from different heights.

Stone	Mass of stone in g	Height dropped from in m
V	100	20
W	100	40
X	200	20
Y	200	40

Which stone has the greatest gravitational potential energy (GPE) when it is dropped?

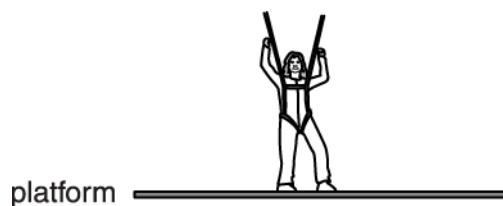
answer _____

Explain your answer.

[3]

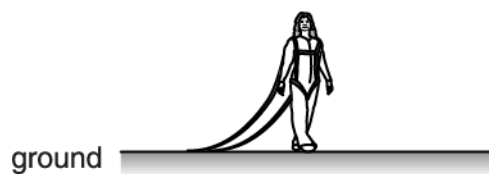
24 Susie practises her landings by jumping from a low platform.

She is attached to straps which act like a parachute.



A Susie **standing still**
on platform.

B Susie is **exactly**
half way down.



C Susie is **on** the
ground.

Look at the statements about Susie's energy as she does her practice fall.

Put a tick (✓) in the box beside any correct statement and a cross (✗) beside any incorrect statement.

The first one has been done for you.

At **A** all of Susie's energy is GPE.



Between **A** and **B** Susie gains **both** GPE and KE.

☐

Between **A** and **B** Susie gains **only** KE.

☐

At **B** her KE is **exactly** half her GPE at **A**.

☐

Just before touching the ground at **C** Susie has her maximum KE.

☐

On the ground at **C** Susie has zero KE.

☐

On the ground at **C** Susie has her maximum GPE.

☐

[3]

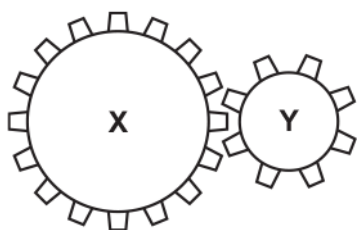
26 What is the gravitational field strength at the Earth's surface?

- A 10 N/kg
- B 16 N/kg
- C 50 N/kg
- D 230 N/kg

Your answer

[1]

27 Cog X has 16 teeth and cog Y has 8 teeth.



Cog X is turned around **two** times.

How many times does cog Y turn around?

- A 1
- B 2
- C 4
- D 8

Your answer

[1]

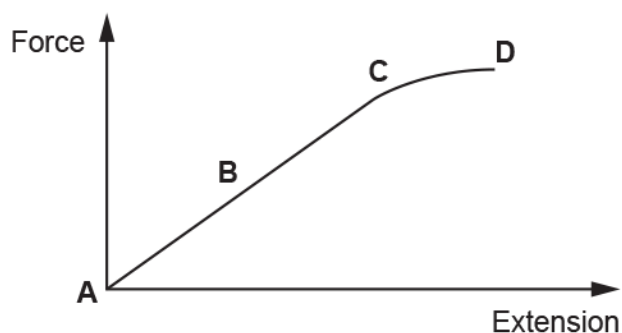
28 What is the **smallest** number of forces needed to bend an object?

- A 1
- B 2
- C 3
- D 4

Your answer

[1]

29 The diagram shows the relationship between force and extension for a spring.



Which letter on the graph shows the **elastic limit** of the spring being stretched?

Your answer

[1]

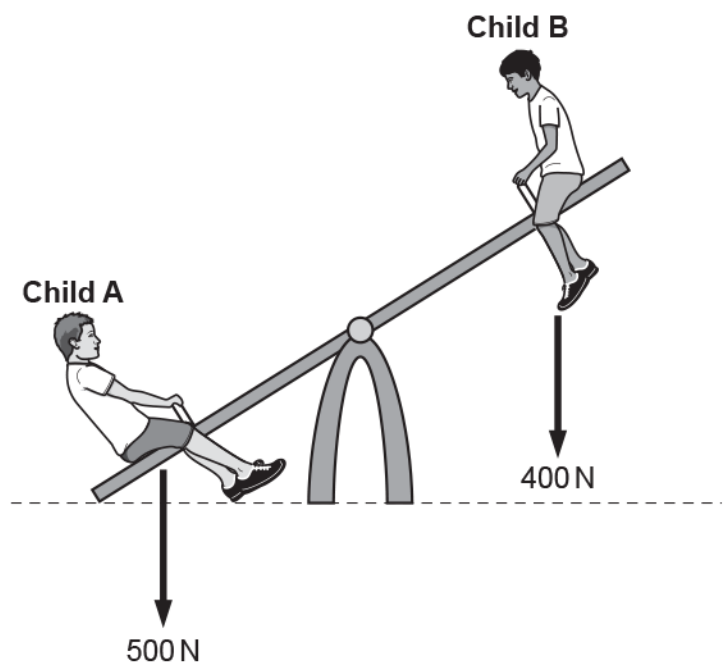
30 In which situation does the force cause a rotation?

- A Bouncing on a trampoline
- B Hitting a nail with a hammer
- C Pushing a friend on a swing
- D Sitting on a chair

Your answer

[1]

31(a) Two children play on a seesaw.



Both children sit 2 m from the pivot.

Calculate the clockwise and anti-clockwise moments around the pivot when the seesaw is horizontal.

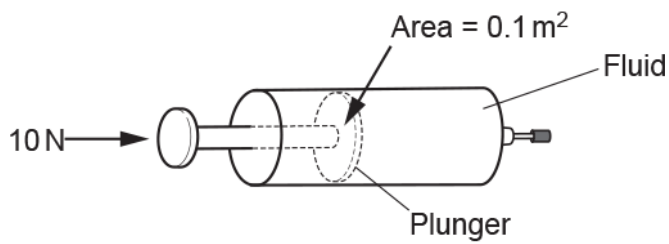
Clockwise moment = ... Nm

Anti-clockwise moment = ... Nm
[3]

Calculate where **Child A** should sit to balance the seesaw.

Answer = ... [3]

(b) A student tries to compress the fluid in a sealed syringe with a force of 10 N.



The area of the end of the syringe is 0.1 m^2 .

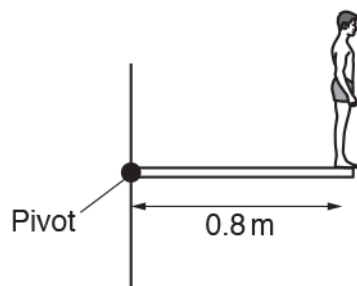
(i) Calculate the pressure in the fluid.

Answer = ... Pa [3]

(ii) Write down the direction of the force produced by the fluid on the plunger.

----- [1]

32 A diver stands on a diving board. He weighs 400 N.



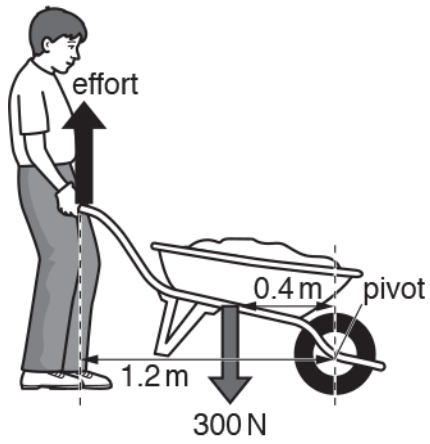
What is the moment of the force provided by the diver around the pivot?

- A 320 Nm anti-clockwise
- B 320 Nm clockwise
- C 500 Nm anti-clockwise
- D 500 Nm clockwise

Your answer

[1]

33 A man lifts a load using a wheelbarrow.



What is the effort needed to lift the load using the wheelbarrow?

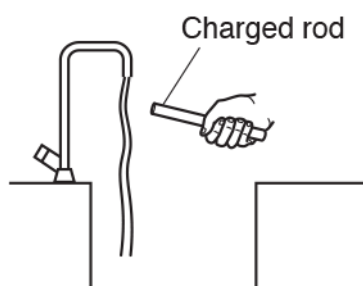
- A 100 N
- B 120 N
- C 250 N
- D 144 N

Your answer

[1]

34 This question is about electrostatic charges.

A charged rod is brought towards a gentle stream of water from a tap.



Explain how the charged rod affects the stream of water.

----- [3]

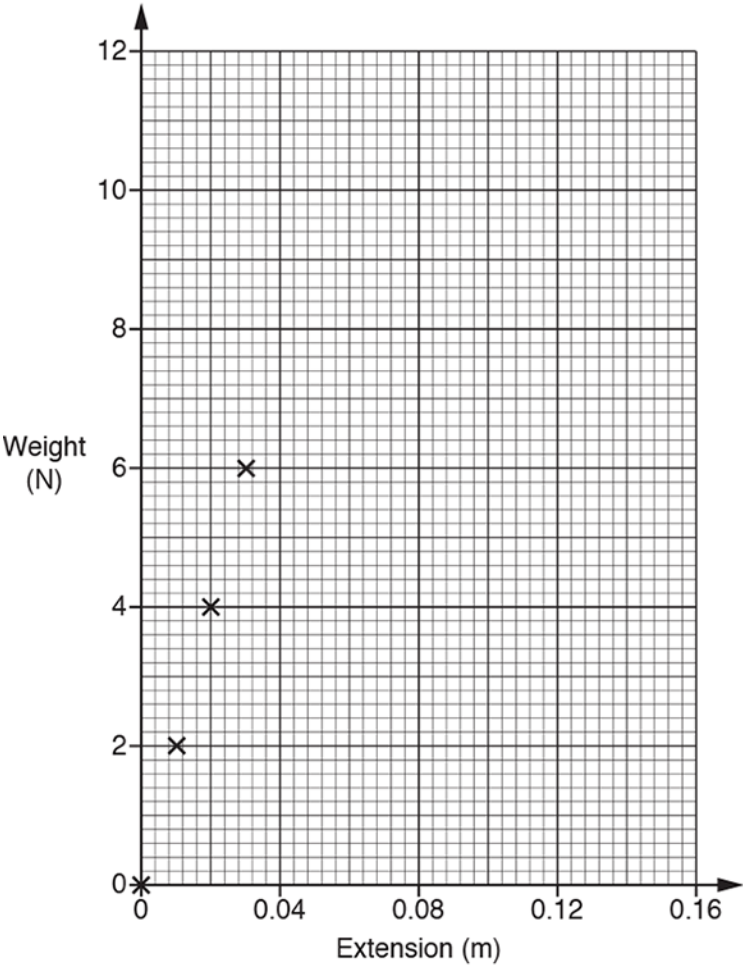
35(a) A student hangs a length of copper wire from the ceiling.

She adds weights to the bottom of the wire and measures the extension of the wire.

Look at a table of some of her results.

Weight (N)	Extension (m)
0	0
2	0.01
4	0.02
6	0.03
8	0.04
10	0.08
12	0.16

(i) Plot the values on the graph. Some have been done for you.



[2]

(ii) Draw a line of best-fit on the graph.

[1]

(iii) Describe **and** explain the shape of the graph.

----- [3]

(b) Calculate the spring constant for the 0 – 6 N part of the graph.

Use the equation: Force = Spring constant $\times$ Extension

Answer = ... N/m [3]

(c) Calculate the work done in stretching the wire to 0.04 m.

Answer = ... J [2]

36(a)

A car has a total weight of 12 000 N. It has four tyres which each have an area of 25 cm² in contact with the road.

Calculate the pressure of the car on the road.

Answer = ... N/cm²

[3]

(b) Seatbelts in cars are made of a wide material that stretches in a crash.



(i) Explain why it is important that the material is **wide**.

----- [1]

(ii) Explain why it is important that the material is **stretchy**.

----- [1]

37 Which one of the following uses of forces causes a rotation?

- A Lowering a book vertically from a shelf
- B Opening a door
- C Lifting a book vertically onto a shelf
- D Sitting in the centre of a see-saw

Your answer

☐

[1]

Children in cars use special seats with their own seatbelts.



The seatbelts for children are narrower than adult seatbelts.

Why is it safe for children's seatbelts to be **narrower** than adult seatbelts?

----- [2]

39 On the Moon, a 10 kg mass has a weight of 16 N.

What is the gravitational field strength on the Moon?

- A 1.6 N / kg
- B 6.0 N / kg
- C 26 N / kg
- D 160 N / kg

Your answer

[1]

40 Which object has the **most** gravitational potential energy?

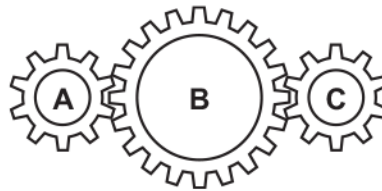
- A 1 kg bag on a shelf 1 m above the ground
- B 2 kg bag on a shelf 1 m above the ground
- C 2 kg bag on a shelf 2 m above the ground
- D 1 kg bag on a shelf 2 m above the ground

Your answer

[1]

41 A student investigates cogs and gears.

Cogs **A** and **C** have 10 teeth. Cog **B** has 20 teeth.



Cog **A** is turned 5 times.

How many times does cog **C** turn?

- A 5 times
- B 10 times
- C 20 times
- D 50 times

Your answer

[1]

42 A spring stretches by 2.0 cm when a force is added.

The spring constant is 60 N / m.

Calculate the energy transferred to the spring when it is stretched.

A 0.012 J

B 0.024 J

C 120 J

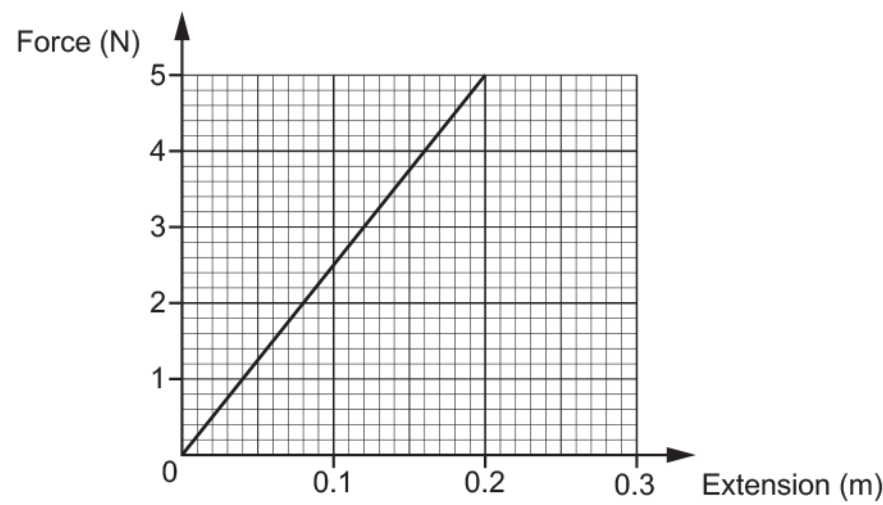
D 240 J

Your answer

[1]

43(a) A student investigates how a spring stretches when a force is added.

Look at a graph of his results.



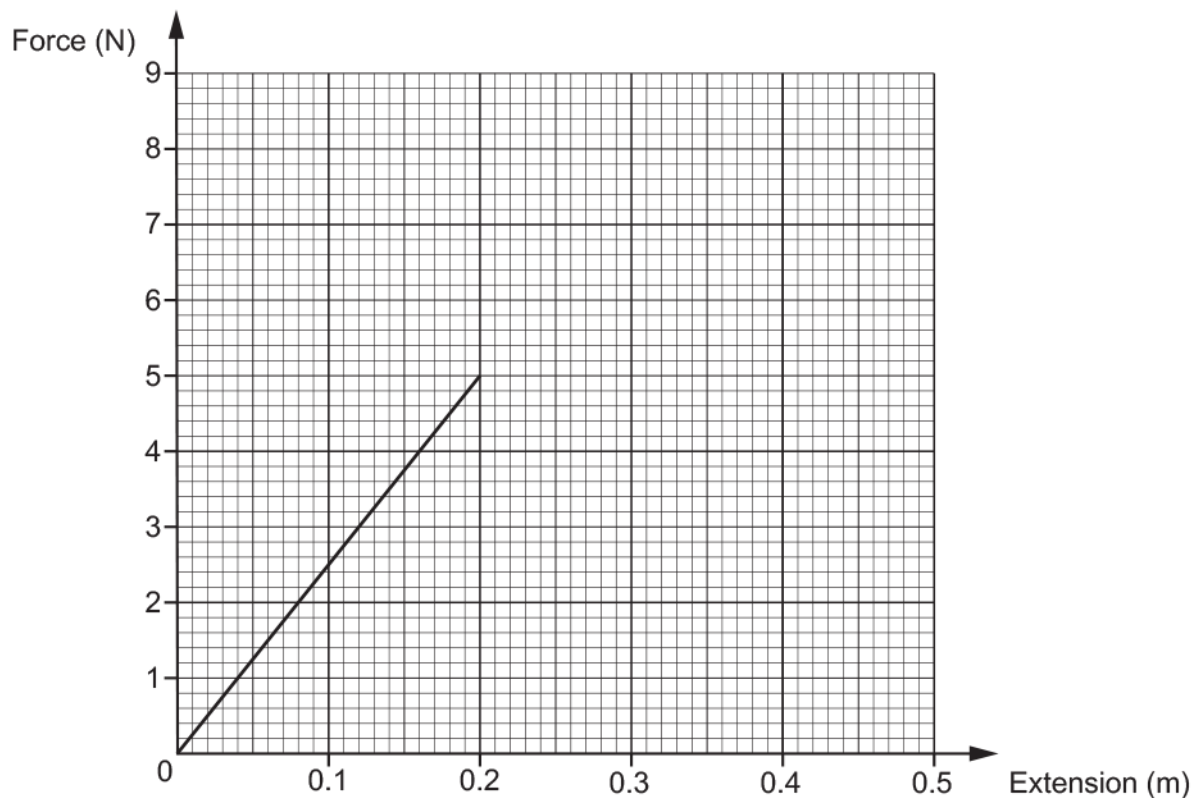
Calculate the spring constant of the spring.

Spring constant = ... N / m [3]

(b) A student investigates how a spring stretches when a force is added.

The student continues to load the spring until it passes its elastic limit.

Complete the force-extension graph and label the elastic limit.



[2]

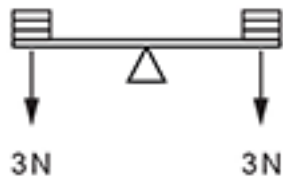
(c) The student puts a small load on the spring. It is in equilibrium.

Draw and label a free body force diagram for the load at the end of the spring.

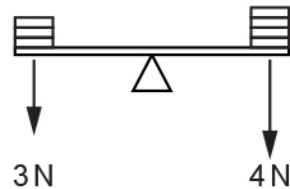
[3]

44 A student puts different weights on four balances.

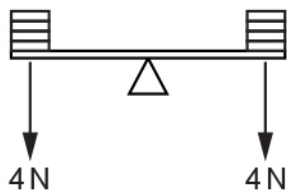
A



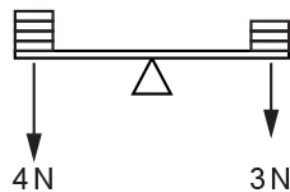
B



C



D



Which balance will give a **clockwise** moment?

Your answer

[1]

45 On Mars the gravitational field strength is 4.0 N / kg .

How much would a 60 kg person weigh on Mars?

Use the equation: $\text{weight} = \text{mass} \times \text{gravitational field strength}$

A 15 N

B 64 N

C 240 N

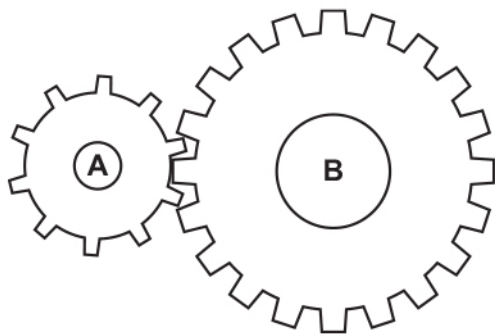
D 600 N

Your answer

[1]

46 A student sets up two cogs.

Cog **A** has 10 teeth and cog **B** has 20 teeth.



Cog **A** is turned 2 times.

How many times does cog **B** turn?

A 0.5 times

B 1 time

C 2 times

D 20 times

Your answer

[1]

47 Which one of the following uses of forces causes a rotation?

A Lowering a book vertically from a shelf

B Opening a door

C Lifting a book vertically onto a shelf

D Sitting in the centre of a see-saw

Your answer

[1]

(d) Describe the differences between elastic and plastic deformation.

----- [2]

49 A boy of mass 65 kg climbs a ladder of height 3.0 m.

Calculate the gain in potential energy of the boy.

Use the equation: potential energy = mass $\times$ height $\times$ gravitational field strength

Gravitational field strength = 10 N / kg.

- A 30 J
- B 195 J
- C 650 J
- D 1950 J

Your answer [1]

50 An elephant has a weight of 60 kN. Its four feet have a total area of 0.75 m² in contact with the ground.

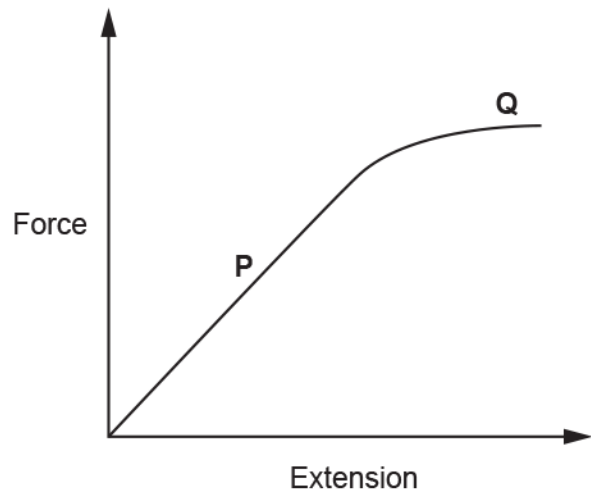
Calculate the total pressure the elephant exerts on the ground.

Use the equation: pressure = force normal to a surface / area of that surface

- A 45 Pa
- B 80 Pa
- C 45 000 Pa
- D 80 000 Pa

Your answer [1]

51 A student plots a force-extension graph for a material.



Which row in the table correctly identifies part P and part Q of the graph?

	Part P	Part Q
A	Elastic	Elastic
B	Elastic	Plastic
C	Plastic	Elastic
D	Plastic	Plastic

Your answer

[1]

52 An astronaut on the Moon lifts a 5.5 kg object a vertical distance of 50 cm.

Calculate the potential energy gained by the object.

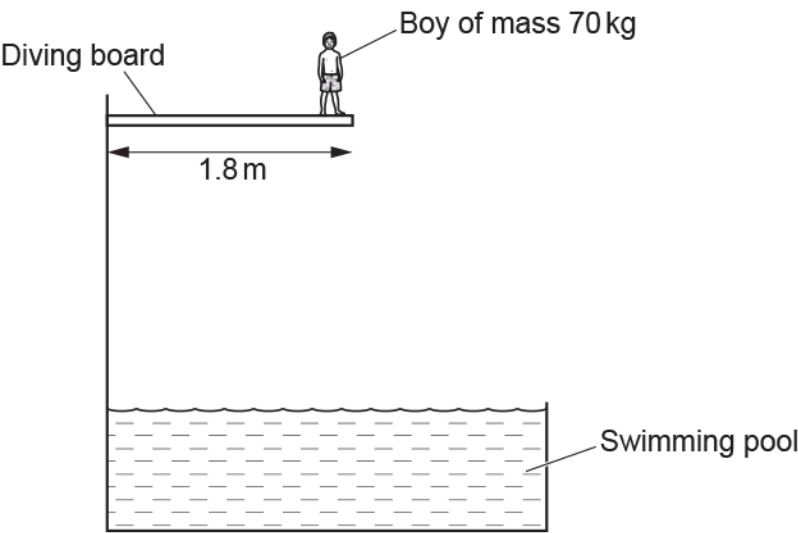
Gravitational field strength on the Moon = 1.6 N / kg.

- A 4.4 J
- B 8.8 J
- C 17.6 J
- D 440 J

Your answer

[1]

53 A boy of mass 70 kg stands on the end of a diving board at a distance of 1.8 m from the wall.



Calculate the moment of the boy standing on the diving board.
Gravitational field strength on Earth = 10 N / kg.

Moment = ... N m [4]

54 A skydiver falls from a plane.



What is the name of the **downward** force in the diagram?

- A Drag
- B Electrostatic
- C Mass
- D Weight

Your answer

[1]

55 On the Moon the gravitational field strength is 1.6 N / kg .

Calculate the gravity force for an 80 kg astronaut.

Use the equation: gravity force = mass $\times$ gravitational field strength

- A 50 N
- B 128 N
- C 800 N
- D 1280 N

Your answer

[1]

56 A student measures the weight of four boxes and the area in contact with the ground.

Box	Weight (N)	Area (cm ²)
A	50	100
B	75	250
C	90	400
D	100	500

Which box exerts the greatest pressure on the ground?

Your answer

[1]

57(a) A student investigates how a spring stretches.

She measures the original length of the spring, adds a 2.0 N weight, and then measures the extended length of the spring.

Look at her data in the table.

Force used	2.0 N
Original length	3.0 cm
Extended length	7.0 cm
Extension	4.0 cm

(i) Calculate the spring constant for the spring.

Use the equation: force = spring constant $\times$ extension

Spring constant = ... N / cm [3]

(ii) Suggest **two** ways that the student could improve and develop their method to find the spring constant.

-----[2]

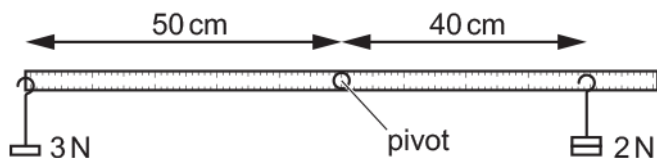
(b) The spring constant of a different spring is 40 N / m.

Calculate the energy stored in the spring when it is stretched 0.20 m.

Use an equation from the data sheet to help you.

Energy stored = ... J [4]

(c) The diagram shows an experiment a student set up to study moments.



The student:

- holds the metre rule so that it is horizontal
- adds weights to the metre rule at different distances from the pivot.

(i) Calculate the moments of the 2 N weight and the 3 N weight about the pivot.

Use the equation: $\text{moment} = \text{force} \times \text{distance from pivot}$

Moment of 2 N weight = ... N cm

Moment of 3 N weight = ... N cm
[2]

(ii) Which way will the metre rule rotate when it is released by the student?

----- [1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			B	1	
			Total	1	
2			D	1	
			Total	1	
3			B	1	
			Total	1	
4			B	1	
			Total	1	
5			B	1	
			Total	1	
6	a		A (1) It is the steepest gradient (1)	2	
	b		It has passed its elastic limit or it no longer obeys Hooke's Law (1) (The spring is) permanently deformed / distorted or (the spring) has undergone plastic deformation (1)	2	
	c	i	$0.5 \times 27 \times (0.25^2)$ (1) 0.84 (J) (1)	2	ALLOW 0.25 (1) for conversion of cm to m.
		ii	Record the original length (1) Add a mass (1) Recorded the new length (1) Repeat for increasing masses (1)	4	
		iii	Any two from: Use smaller weights (1) Use a longer ruler (1) Clamp the clampstand to the bench so it will not topple (1)	2	
			Total	12	
7			B	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a		Recall weight = mass $\times$ gravitational field strength (1) Substitute: 185×3.75 (1) 694 to 3 sig.figs (2) N (1)	5	ALLOW 693.75 (1) but no marks for significant figures
	b		'g' is greater on Earth than Mars / weight is bigger as 'g' is greater on Earth (1)	1	
			Total	6	
9	a		59 (anomalous result should be left out of calculation) (1)	1	
	b		28 (1)	1	
	c		Green results unreliable / large variation / anomalous result (1) Should have repeated 31 (green) reading / other results (red, blue, white, yellow) are reliable (1) A sensible suggested improvement (1)	3	e.g. use camera to measure bounce heights (1)
	d	i	bounce height / drop height $\times 100\%$ = 85% useful, therefore 15% wasted. (1) transferred to heat and sound (1)	2	
		ii	If the bounce height was greater then the efficiency would be higher / ORA (1)	1	
			Total	8	
10			B	1	
			Total	1	
11			C	1	
			Total	1	
12			D	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13			A	1	
			Total	1	
14			D [1]	1	allow correct answer circled, ticked or underlined if no answer on the answer line Examiner's Comments Tested the idea of force = rate of change in momentum. About half the candidates answered the question successfully.
			Total	2	
15		i	B [1]	1	allow correct answer circled, ticked or underlined if no answer on the answer line
		ii	A [1]	1	allow correct answer circled, ticked or underlined if no answer on the answer line Examiner's Comments In this question candidates again confused kinetic and potential energy, with a significant number giving the answers to maximum KE and maximum PE the wrong way round.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16		i	703 scores (2) but if answer is incorrect 185 × 3.8 scores (1)	2	Examiner's Comments Most correctly calculated the weight on Mars.
		ii	any two from: weight of Rover on Earth is 1850 (N) /AW (1) too heavy on Earth (1) weight too near to safe limits / more likely to break (1)	2	allow Rover is 50 (N) more than it can take (2) allow heavier / weighs too much (1) e.g. legs / wheels not able to support (1) incorrect statement about mass scores a maximum (1) Examiner's Comments Most candidates wrote about the Rover being too heavy or heavier on Earth (often without any reference to the information given). A small number calculated its weight correctly. Many candidates did not use the information in the table to apply to the question but simply compared gravitational field strengths.
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17		i	lower speed (than 8000 m/s) then: –centripetal / gravitational force too high (to stay in this orbit) [1] –rocket may fall / move or spiral to Earth [1] higher speed (than 8000 m/s) then: –centripetal / gravitational force too low (to stay in this orbit) [1] –rocket may move away from Earth / spiral out of orbit [1] (idea of) higher stable orbits experience lower gravitational force or lower speed / ORA [1]	3	Eg. rocket may fall as centripetal / gravitational force is too big [2] Eg. rocket may move away as centripetal / gravitational force is too small [2] allow any idea that correct speed needed to allow correct angle of re-entry to avoid overheating [1] <u>Examiner's Comments</u> This was an intentionally challenging question, which required both confidence in the physics and some skill in its communication. Few referred correctly in terms of the forces. The idea that lower speeds would cause the satellite to spiral to Earth was reasonably common. Less common was the idea that at higher speeds the satellites would spiral into space.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	(+/-) 4 (m/s²) scores [3] but if answer is incorrect then: (+/-) $\frac{(120^2 - 2000^2)}{2 \times 5 \times 10^5}$ [2] Or if no other marks scored then evidence of correct substitution into $v^2 = u^2 + 2as$ or evidence of rearranged formula: $\frac{v^2 - u^2}{2s}$ [1]	3	allow 3.99 / 3.9856 (m/s²) [3] <u>Examiner's Comments</u> The calculation of deceleration was challenging but it discriminated well with about a quarter gaining full marks.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18			[Level 3] Describes how KE changes in both sections AND describes how GPE changes in both sections AND calculates the maximum KE or difference in height. Quality of written communication does not impede communication of the science at this level. (5–6 marks) [Level 2] Describes how KE AND how GPE changes for both sections OR describes correctly how KE changes over both sections and calculates maximum KE OR describes correctly how GPE changes over both sections and calculates maximum KE OR calculates difference in height. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) [Level 1] Realises that KE depends on speed and describes changes over part of journey OR describes how GPE changes over part of journey OR attempts to calculate maximum KE / height OR loss in KE = gain in PE (on either section) OR A Quality of written communication impedes communication of the science at this level. (1–2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A* Ignore points after C Indicative scientific points at all levels may include: • KE increases from A to B • KE decreases from B to C • GPE decreases from A to B • GPE increases from B to C • loss in GPE = gain in KE • $KE = \frac{1}{2} mv^2$ • maximum KE = 51200J • $GPE = mgh$ • $51200 = mgh = 400 \times 10 \times h$ • height = 12.8m Use the L1, L2, L3 annotations in Scoris; do not use ticks. <u>Examiner's Comments</u> This six-mark level of response question proved to be the most challenging of the three on the paper. It did involve a data-handling element to the question. The graph, for many looked like a roller coaster track, so about a third of students described the motion along this track. A sizeable minority scored low marks for having the whole thing the wrong way round. Many thought that A to B was climbing and B to C was falling. The more able calculated the height correctly. Again this question discriminated well at the higher grades with approximately 10% scoring five or six marks. About 10% also failed to attempt this question at all.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a		11.25 m (3) but if incorrect $56.25 = 5 \times h$ (2) but if incorrect $KE = \frac{1}{2} \times 0.5 \times 15 \times 15$ (1) or $m g h = \frac{1}{2} m v^2$ / $PE = KE$ (1)	3	allow $56 = 5h$ (2) 11.25 (3) if incorrect time = 1.5 (seconds) (1) average speed = 7.5 (1) allow other correct calculations using equations of motion Examiner's Comments Candidates were asked to calculate the distance a rock fell from a cliff. They were given the hint that it gained kinetic energy and lost gravitational potential energy. Despite this hint only about one in five candidates scored on this section.
	b		any one from (idea that the) mass cancels out on the equation (1) (idea that without air resistance) both masses have the same acceleration (and so reach the same speed in the same time) (1)	1	Examiner's Comments Candidates were asked why a rock of double the mass hit the ground at the same speed. Examiners were looking for the idea that mass cancelled out in the two equations or that all objects fell with the same acceleration due to gravity. Many candidates mistakenly confused mass and weight. This question was about the transfer between kinetic energy and gravitational energy for falling objects. Candidates struggled with both parts of this question.
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20		i	703 (N) scores (2) but if answer is incorrect 185 × 3.8 scores (1)	2	Examiner's Comments Most correctly calculated the weight on Mars as 703N [2].
		ii	any two from: weight of Rover on Earth is 1850 (N) / AW (1) too heavy (on Earth) (1) weight too near to safe limits / more likely to break (1)	2	allow Rover is 50 (N) more than it can take (2) allow heavier / weighs too much (1) eg. Legs / wheels not able to support (1) incorrect statement about mass scores a maximum of (1) Examiner's Comments Most wrote about the Rover being too heavy or above the recommended weight limit on the legs [1]. Others calculated its weight correctly as 1850N [1]. Some concise answers were seen such as 'it is 50N above the weight limit' [2].
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
21			weight - 2500 (N) (1) distance - 2(m) (2) but if final answer is incorrect then look for: $d = W / F$ 5000 / 2500 and award (1)	3	allow 5000 divided by incorrect calculated weight Eg weight = 25N (0) 5000 / 25 scores (1) but 5000 / 25 = 200 scores (2) 200m without working scores 0 Examiner's Comments In this common question targeted at C/D grades many candidates correctly calculated the weight but rather fewer could go further and calculate the height. These weaker candidates could usually get the weight mark but confused mass and weight in the formula for work or simply did not attempt that part.
			Total	3	
22			weight – 2500 (N) (1) distance – 2 (m) (2) but if final answer is incorrect then look for: $d = W / F$ 5000 / 2500 and award (1)	3	allow 5000 divided by incorrect calculated weight Eg weight = 25N (0) 5000 / 25 scores (1) but 5000 / 25 = 200 scores (2) 200m without working scores 0 Examiner's Comments About three quarters of candidates were able to calculate the weight of the bar as 2500N but only about one third of these were able to calculate the height that he lifted the bar as 2m. Many found difficulty in rearranging the equation to make distance the subject.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
23			Y (1) because Y has largest mass / one of the largest masses / AW (1) biggest height / one of the biggest heights / AW (1) or all GPE calculations shown V = 2000 / W = 4000 / X = 40000 and Y = 80000 (2)	3	allow greatest weight or greatest force allow calculations eg 200×40 is the greatest (G) PE / AW (3) ignore heaviest if Y is not chosen allow for max (1) - greater or big height if W is chosen - greater or larger mass if X is chosen Examiner's Comments Candidates can tackle this type of question more confidently. They can look at data and come to sensible conclusions based on their grasp of ideas in physics. The vast majority gained partial or full credit (almost 30% gained all 3 marks). Vague references to 'high' or 'heavy' reduced the potential mark in some responses. Crude calculations (i.e. using the idea of 'mgh' without conversion of mass and / or height to kilograms / metres) were credited since the use of GPE in Item h of Unit P3 is aimed at grade C and above and this question was targeted at grades E, F and G. Answers with calculations therefore did reflect the idea of Y having the greatest GPE by virtue of greatest mass and highest drop height.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
24			At A all of Susie's energy is GPE.	(✓)	3 Use marking tool on scoris to identify the crosses all 6 correct (3) 4 or 5 correct (2) 2 or 3 correct (1) only 1 correct (0) ignore blank boxes Examiner's Comments Although this was an objective question it remained high demand. 10% gained all marks here. Some candidates ticked but did not cross in the boxes. Blank boxes were ignored by examiners. Most candidates gained [1] or [2] marks here.
			Between A and B Susie gains both GPE and KE.	✗	
			Between A and B Susie gains only KE.	✓	
			At B her KE is exactly half her GPE at A .	✗	
			Just before touching the ground at C Susie has her maximum KE.	✓	
			On the ground at C Susie has zero KE.	✓	
			On the ground at C Susie has her maximum GPE.	✗	
Total			3		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
25			Level 3: 5–6 marks Explains fully the changes in KE and GPE between A and B or B and C. Quality of written communication does not impede communication of science at this level. Level 2: 3–4 marks Gives a partial explanation of the changes in GPE and KE between A and B or B and C Quality of written communication partly impedes communication of science at this level. Level 1: 1–2 marks Simple statement about KE and GPE. Quality of written communication impedes the communication of science at this level Level 0: 0 marks Insufficient or irrelevant science. Not worthy of credit.	6	This question is targeted up to grade C Indicative scientific points may include (but are not limited to) the following: <u>KE Statements</u> at A kinetic energy is zero / a minimum at B kinetic energy is a maximum at C kinetic energy is zero / a minimum allow correct changes e.g. KE increases from zero to a maximum between A and B / decreases from maximum to zero between B and C <u>GPE Statements</u> (allow PE for GPE) at A gravitational potential energy is a maximum at B gravitational potential energy is a minimum / zero at C gravitational potential energy is a maximum allow correct changes e.g. GPE decreases from maximum to minimum between A and B / increases from minimum to maximum between B and C allow GPE for gravitational potential energy allow just potential energy for GPE as this is in the question allow KE for kinetic energy allow PE at C is less than PE at A simple statements include: car has KE at B Car has PE at A or C KE depends on speed PE depends on / increases with height
			Total	6	
26			A ✓	1 (AO1.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
27			C ✓	1 (AO2.2)	
			Total	1	
28			B ✓	1 (AO1.1)	
			Total	1	
29			C ✓	1 (AO1.2)	<u>Examiner's Comments</u> Just over half of all candidates got this correct. The most common wrong answer here was D; candidates need to realise that 'elastic behaviour' for a spring is intended to refer to the straight-line section of the graph.
			Total	1	
30			C ✓	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
31	a	i	moment = force $\times$ distance ✓ clockwise moment = 800 (Nm) ✓ anti-clockwise moment = 1000 (Nm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW 2 marks (total) if clockwise and anti-clockwise moments are reversed Correct calculation of either moment implies correct equation so gets m.p.1 also <u>Examiner's Comments</u> Some candidates were confused as to the direction of rotation of 'clockwise' and 'anticlockwise', so credit was allowed to those who reversed their sense. Many candidates did not know how to calculate a moment, although this could be deduced from the units provided in the answer line (telling them to multiply the two). The unit Nm is the product of the force (N) and the distance (m) of each child from the pivot point of the seesaw.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.6 (m) award 3 marks (anti-clockwise moment) 500 (N)$\times$distance = 800 (N m) ✓ distance = 800 $\div$ 500 ✓ = 1.6 (m) ✓	3 (AO1.2) (AO2.2) (AO2.2)	E.c.f. clockwise moment from (a)(i) for 800 (N m) If child B chosen, giving 1000 $\div$ 400 = 2.5 (m), award 2 marks (loses m.p.1) <u>Examiner's Comments</u> Many candidates did not identify that the command word "calculate" was asking them to provide a mathematical solution rather than a qualitative descriptive of where child A should sit. Several candidates did calculate the correct answer and showed their workings in the space provided.
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Pa) award 3 marks pressure = force $\div$ area ✓ = 10 $\div$ 0.1 ✓ = 100 (Pa)✓	3 (AO1.2) (AO2.1) (AO2.1)	<u>Examiner's Comments</u> Many candidates were not able to recall the equation $P = F/A$. Some candidates did recall the equation and correctly calculated the pressure in the fluid as 100 Pa. A common misconception was using the equation $P = F \times A$ to calculate the pressure as 1 Pa.

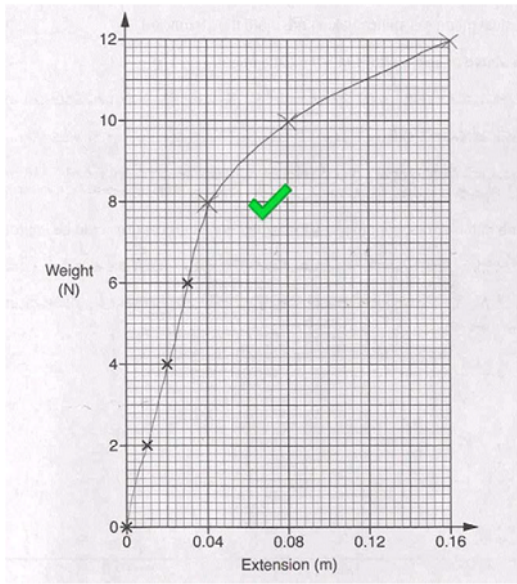
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	at right angles/perpendicular/90° (to the plunger)	1 (AO1.1)	ALLOW to the left opposite to the force from the plunger <u>Examiner's Comments</u> Many answers here bore no relationship to the diagram: Any clear indication of direction including 'left' or 'at right angles' or 'perpendicular/90° to the plunger' were accepted. Ambiguous and inappropriate directions such as 'to the east' were not credited.
			Total	10	
32			B	1 (AO2.1)	<u>Examiner's Comments</u> This was the first calculation on the paper and about 80% gave the correct answer B. A common incorrect response was 'A', presumably due to confusion over clockwise and anticlockwise.
			Total	1	
33			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> In this calculation about a third of candidates gave the correct answer A. The other distractors were randomly selected.
			Total	1	

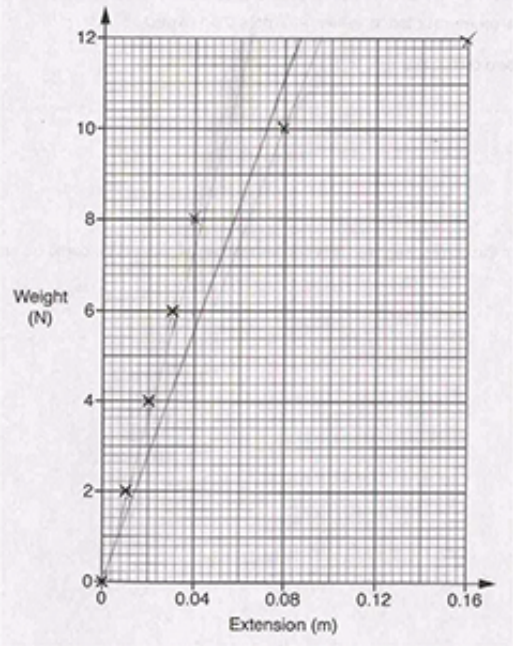
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
34			Rod attracts water ✓ • Opposite charges attract ✓ • water has both + and – charges / idea of polarisation / AW ✓	3 (AO3 × 1.2)	IGNORE positive electrons / movement of protons / ions for this answer. ALLOW Water bends or moves towards rod OR for candidates that have misinterpreted the diagram as repulsion of water then ALLOW Rod repels water / water bends or moves away from rod ✓ • Like charges repel ✓ • water has both + and – charges / idea of polarisation / AW ✓ <u>Examiner's Comments</u> The diagram was interpreted differently by candidates. Some thought it attracted (ideal scenario) and others thought it repelled. However marks were made available for both lines of thought as both interpretations were valid from the diagram. It gave a full range of marks and discriminated well with about 10% gaining full marks by including the idea of polarisation. The ideas of repulsion of water and opposite charges repelling were credited 2 marks.
			Total	3	

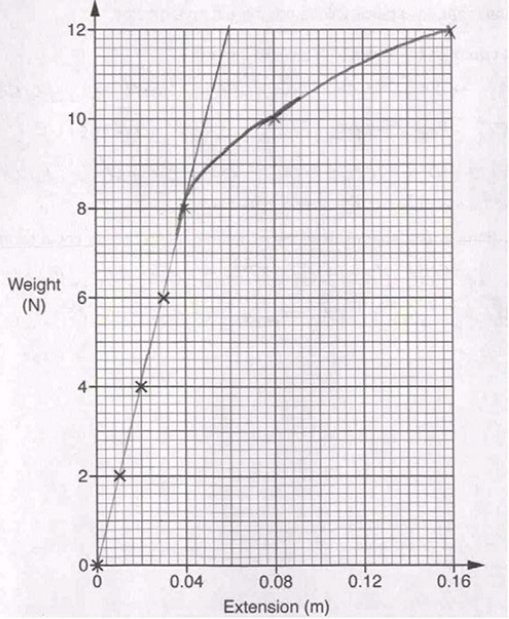
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
35	a	i	All three points correctly plotted ✓✓ OR two points correctly plotted ✓	2 (AO 2 × 2.2)	Points should be + / – ½ square or less (by eye) <u>Examiner's Comments</u> All the points were usually plotted correctly.
		ii	straight line up to 0.04, 8 and curved line consistent with points plotted past this point ✓	1 (AO 3.1a)	ALLOW ecf from part ai for misplotted points ALLOW straight part of graph drawn without ruler. DO NOT ALLOW dot-to-dot for curve Single line should be thin (less than ½ square thick) and continuous to gain the mark. <u>Examiner's Comments</u> Just over half of answers gained the one mark here. Common mistakes were double lines, lines too thick (larger than half a square) and straight line of best fit with no curve. Exemplar 1  This gets full marks for both parts as the answer shows accurate plotting for part i of

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			the question and produces a straight line graph in part ii that becomes curved after 8N. Although the line does slightly miss the point at 8N, the line and curve are reasonable. Exemplar 2  This was a common error with points plotted accurately but a straight line drawn so this was credited 0 marks. Exemplar 3

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			 This shows two lines, one curved and one straight. The marker cannot give credit as they are unsure which one to mark. In any case the curved line would have been too thick to award the mark as it is thicker than half a square.
iii	Initially the extension increases steadily / linearly / uniformly / (directly) proportionally / elastically / AW ✓ (then the) wire reaches its elastic limit ✓ the extension increases plastically / by more for each (2N) weight added (past this point) / AW ✓	3 (AO 3.1a) (AO 1.2) (AO 3.1a)	ALLOW gradient is steady up to 8N ALLOW initially obeys Hooke's law IGNORE limit of proportionality (as this is an AO3 answer for an AO1 question) ALLOW Hooke's law not obeyed after 8N <u>Examiner's Comments</u> This gave a good range of marks with most describing the first stage as extension is linear or proportional. Some clearly referred to elastic limit [1 mark] although vague answers such as 'limit of proportionality' was frequently seen [0 mark]. Some were successful in describing the extension after the limit is reached.

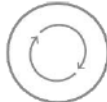
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 200 (N/m) award 3 marks $k = F \div x$ ✓ $k = 6 \div 0.03$ ✓ (or equivalent correct expression from 0 to 6N) $k = 200$ (N/m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	IGNORE $F=kx$ Substitution into correctly rearranged formula ✓✓ <u>Examiner's Comments</u> This calculation, like many on the paper was answered well. Here about third quarters of answers gained all three marks. For unsuccessful calculations however, 1 mark was given for the correct rearrangement of the formula $k = F \div x$.
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.16 (J) award 2 marks $E = 0.5 \times 200 \times 0.04^2$ ✓ $E = 0.16$ (J) ✓	2 (AO 1.2) (AO 2.1)	ALLOW ecf from part b ALLOW area under graph method: $0.5 \times 8 \times 0.04$ ✓ BUT area under graph method used to calculate 0.16 scores ✓✓ <u>Examiner's Comments</u> Most candidates incorrectly used 'work done = force $\times$ distance' giving the answer 0.32 (J). Better answers used $E = 0.5 \times 200 \times 0.4^2$ to successfully get 0.16 (J) and gained full marks.
			Total	11	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
36	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (N/cm²) award 3 marks Recall: pressure = force ÷ area ✓ 12000 ÷ 100 OR 40000 ÷ 25 ✓ = 120 (N/cm²)	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW 12000÷25 for one mark ALLOW for two marks 480 (N/cm²) <u>Examiner's Comments</u> Candidates are advised to start their response to this type of question by writing down the appropriate equation. They should then substitute the numbers from the stem of the question into the equation before they calculate the answer. Making sure to write down each stage of the process. A common error was candidates who had not allowed for the four tyres and gave a final answer of 480 N/cm².

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	1 (AO 1.1)	Examiner's Comments Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'.  AfL The parts of a question form a story that develops a central theme. In part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in (i) and (c) most candidates did not make the connection after they were asked to calculate pressure in (a).
		ii	Absorb energy (in a crash) ✓	1 (AO 1.1)	ALLOW higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop Examiner's Comments Higher ability candidates realised that the material was stretchy to absorb energy in a crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	5	
37			B ✓	1 (AO1.1)	Examiner's Comments Most candidates understood that a moment is required to cause a rotation.
			Total	1	
38			Mass / inertia of child is lower ✓ Less force is needed (for the same deceleration)✓	2 (AO 2.1) (AO 1.1)	ALLOW weight of child is lower/child is smaller Examiner's Comments Many candidates suggested that the narrower belts were needed because of child car seats are smaller.
			Total	2	
39			A ✓	1 (AO2.1)	Examiner's Comments This question was generally answered well. Candidates should be encouraged to consider the units. In the units in each answer is given as N / kg, then 16 N should be divided by 10 kg giving an answer of 1.6 N / kg.
			Total	1	
40			C ✓	1 (AO2.1)	Examiner's Comments The majority of candidates realised that the mass ($\times g$) $\times$ distance above the ground was needed. For this type of question, it is good to calculate the potential energy for each option.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
41			A ✓	1 (AO1.1)	<u>Examiner's Comments</u> This question was generally answered well. For the cogs shown since the reverse must also be true, response A was straightforward. Candidates who did not gain this mark often chose response B.
			Total	1	
42			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> This was well answered by higher ability candidates. Often the half or the change of unit (cm to m) was missing. Higher ability candidates wrote the equation from the data sheet, then substituted the numbers into the equation and then carried out the calculation.
			Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
43	a	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 25 (N/m) award 3 marks Recall and rearrange: spring constant = force exerted by a spring ÷ extension ✓ = 5 ÷ 0.2 ✓ = 25 (N/m) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW any other correct pair of points from the graph – points to be read to $\pm\frac{1}{2}$ a small square Final answer between 24 and 26 (N/m) scores three marks <u>Examiner's Comments</u> The majority of candidates scored highly on this question. Higher ability candidates stated either the equation for spring constant or stated that the spring constant was the gradient of the graph. It was then expected that candidates would substitute into their equation appropriate values from the graph. A small but significant minority of candidates tried to use the same equation from the data sheet which had been used to determine the energy transferred and substituted in a force for the energy. This approach was not creditworthy.  AfL Candidates should be able to read information from graphs and determine a gradient.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		Line curves and gradient decreases ✓ Point at the end of the linear section of the line labelled 'elastic limit' ✓	2 (AO2x 1.2)	IGNORE poorly drawn curves/thick lines DO NOT ALLOW curve with negative gradient at any point <u>Examiner's Comments</u> This question required candidates to demonstrate that they understood how a spring stretched with an increasing force and the term "elastic limit". For marks to be given the straight line section (if any) should be drawn with a ruler and the curve should be smooth. Sometimes the labelling of the elastic limit was vague. Higher ability candidates added a small cross at the elastic limit and then labelled the cross. Exemplar 2 (b) The student continues to load the spring until it passes its elastic limit. Complete the force-extension graph and label the elastic limit. This candidate has clearly extended a straight line and then drawn a curve with decreasing gradient which gains the first mark. The labelling of the elastic limit is vague and incorrect. It would have been helpful if this candidate had indicated precisely on the line with a dot or cross where the elastic limit is located and then added a label.
	c		A downwards arrow labelled weight/load ✓	3 (AO3x 2.2)	DO NOT ALLOW labels pointing to apparatus ALLOW gravity/gravitational force

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			An upwards arrow labelled tension ✓ <u>Two</u> equal length arrows (by eye), one vertically up and one vertically down ✓		DO NOT ALLOW mass ALLOW force from spring NOTE this mark may not be scored if more than two arrows are drawn <u>Examiner's Comments</u> A small majority of candidates gained at least two marks for this question. Most of these candidates drew two arrows of equal length and labelled correctly the weight or gravitational force. Few candidates labelled the upwards arrow "tension" or "force from spring". A common misconception was the use of the term "upthrust". When representing vectors by straight lines, candidates should be encouraged to use a ruler with a millimetre scale. Ideally candidates should refer to the gravitational force as "weight" or "force due to gravity" rather than "gravity". A few candidates did not understand a "free body force diagram" and drew the apparatus and labelled the apparatus. Other errors were the drawing of many arrows on the diagram in varying directions. Exemplar 3  This candidate has drawn a "free body force diagram" with two arrows of the same length – the candidate confirms that the arrows are the same length. Force of load was allowed for one of the label marks.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
44			B ✓	1 (AO2.2)	
			Total	1	
45			C ✓	1 (AO2.1)	
			Total	1	
46			B ✓	1 (AO1.1)	
			Total	1	
47			B ✓	1 (AO1.1)	Option B was the correct answer. Option D was a common misconception, probably because the phrase 'see-saw' suggested rotation to many candidates. <u>Examiner's Comments</u>  Rather than focus on a single word like 'see-saw' in the stem of a question, it can be helpful for candidates to try and visualise each of the operations described. At the pivot a see-saw does not move. The book is moving down in A and up in C. However the door is rotating on its hinges.
			Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
48	a	Any three from: Measure original length (using the ruler) ✓ Add the 2N weight ✓ Measure the extended length and use Extension = extended length – original length ✓ Use $k = F \div x$ to determine k ✓	3 (AO1.2 x3)	ALLOW measure the extension/how far it stretched Examiner's Comments Only a few candidates stated how the spring constant should be calculated by referring to <i>spring constant = force exerted by the spring ÷ extension</i>. However as the mark scheme allowed for any of the four marking points to count towards the total many candidates gained all 3 marks without reference to the spring constant equation. Exemplar 3 was a typical response and gained two marks. This candidate did realise a calculation was needed but decided it should be $E = \frac{1}{2} k x^2$. This energy equation (which was on the data sheet) was given in more candidate answers than the expected force = <i>extension x spring constant</i> Exemplar 3 18 A student has a spring, a ruler and a 2.0 N weight. (a) Describe how the student can use this equipment to determine the spring constant of the spring. the student can attach the spring to a stand and a clip, then put the weight on the end of the spring, measuring how far it extends. Then use the equation $\text{energy transferred in stretching} = 0.5 \times \text{spring constant} \times (\text{extension})^2$ [3]
	b	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 400 (Pa) award 2 marks $P = 2 \div 0.005$ ✓ $P = 400$ (Pa) ✓	2 (AO2.1) (AO2.1)	Examiner's Comments Relatively few candidates had problems with dividing by 0.005.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		Two (or more) forces (are needed) ✓ Acting in different directions ✓	2 (AO1.1) (AO1.1)	Multiple forces are implied by the use of certain verbs e.g. squash, twist, squeeze ALLOW the marking points shown on a diagram Idea of second force can be implied by fixing one end/part of the material ALLOW clear use of tension or compression for both marks <u>Examiner's Comments</u> The key factors which were needed here were that more than once force is necessary, and that those forces must act in different directions. The 'multiple forces' idea was accepted to be implied by the use of some verbs, for example squash, twist, squeeze and crush. The 'opposite directions' mark could be gained by setting up a situation where the opposition was obvious, for example by putting the object on a table and pushing down from above
	d		Plastic – stays deformed (when force is removed) ✓ Elastic – returns to original shape (when force removed) ✓	2 (AO1.1) (AO1.1)	ALLOW permanently changed <u>Examiner's Comments</u> Around half of all candidates described plastic deformation and this almost always led on to a description of elastic deformation, or vice versa (a description elastic deformation leading into plastic deformation). Very few candidates only described one form of deformation.
			Total	9	
49			D ✓	1 (AO2.1)	
			Total	1	
50			D	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
51			B	1 (AO1.2)	
			Total	1	
52			A	1 (AO2.1)	
			Total	1	
53			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1260 or 1300 (Nm) award 4 marks (Force = $70 \times 10 =$) 700 (N) ✓ (Moment =) force x distance ✓ (Moment =) 700×1.8 ✓ (Moment =) 1260 (Nm) ✓	4 (AO2.1) (AO1.2) (AO2.1) (AO2.1)	ALLOW ecf for using mass not weight e.g. 3 marks for an answer of 126 (Nm), 2 marks for 70×1.8 ALLOW ecf for incorrect calculation of force ALLOW ecf for converting 1.8m to 180cm e.g. 3 marks for 126 000 (Nm)
			Total	4	
54			D	1 (AO1.1)	
			Total	1	
55			B	1 (AO2.1)	
			Total	1	
56			A	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
57	a	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 (N/cm) award 3 marks (Spring constant =) force ÷ extension ✓ $2.0 \div 4.0$ ✓ $= 0.5 \text{ (N / cm)}$ ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW 3 marks for 50 N/m Needs algebraic or arithmetic rearrangement for this m.p. Choice of <i>F</i> , <i>ext</i> for wrong data point loses mp2 but can get mp3 for evaluation ecf.
		ii	Any two from: Repeat readings and calculate a mean/average ✓ Use more forces ✓ Plot data on a graph (and use a line of best fit) ✓ Use equipment with a higher resolution ✓ Repeat experiment with different equipment (and compare results) ✓	2 (AO3.3b x 2)	
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.8 (J) award 2 marks $\frac{1}{2} \times 40 \times 0.2^2$ ✓ $= 0.8 \text{ (J)}$ ✓	2 (AO2.1) (AO2.1)	ALLOW 3.8 (J)
	c	i	(moment of 2N weight) = 80 (N cm) ✓ (moment of 3N weight) = 150 (N cm) ✓	2 (AO2.1) (AO2.1)	ALLOW 1 mark if answers are reversed
		ii	Anti-clockwise (as anti-clockwise moment is larger than the clockwise moment) / left hand side goes down / AW ✓	1 (AO3.1b)	ALLOW indication of rotation by an arrow on the diagram
			Total	10	