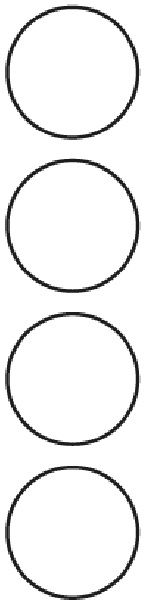
Forces – 2021/20 GCSE Gateway Physics Combined Science A

1. Nov/2021/Paper_J250/05/No.2

Each planet, **A–D**, has the same diameter (width).

Which planet has the largest gravitational field strength?



A Mass = 1×10^{24} kg

B Mass = 2×10^{24} kg

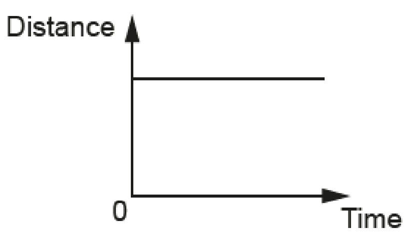
C Mass = 1×10^{26} kg

D Mass = 2×10^{26} kg

Your answer ☐ **[1]**

2. Nov/2021/Paper_J250/05/No.4

This is a distance-time graph for a car.



Which is the correct description of the motion of the car?

A Accelerating

B Decelerating

C Moving at constant speed

D Staying still

Your answer ☐ **[1]**

3. Nov/2021/Paper_J250/05/No.11

Fig. 11.1 shows the plan view of the corridor in a school building. The arrow shows the path students must take to get from **Room 1** to **Room 4**.

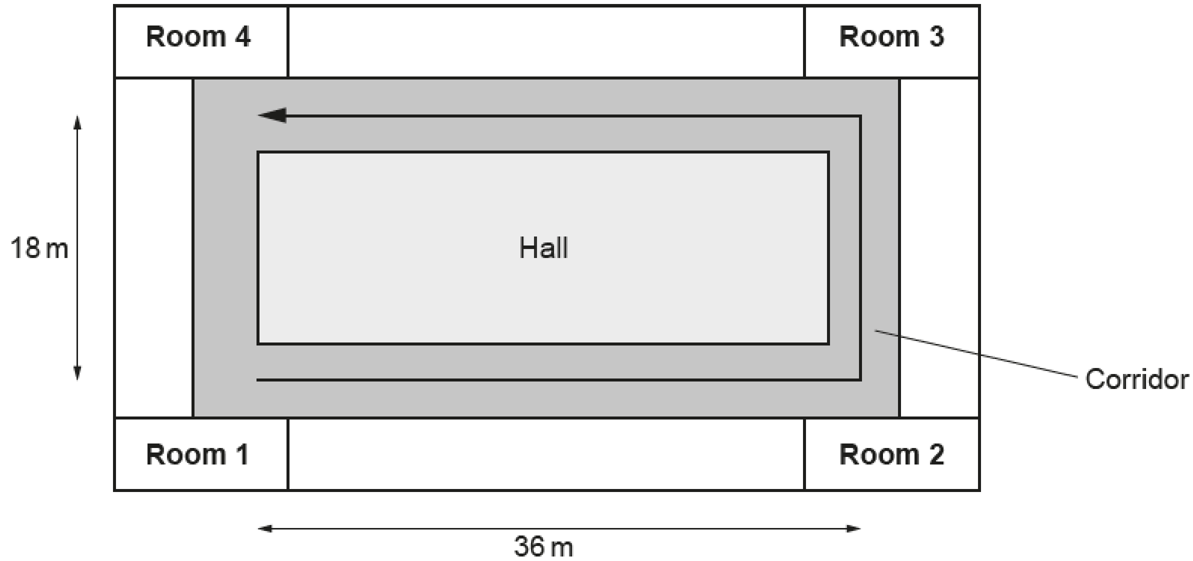


Fig. 11.1

(a) Student **A** says:

'The displacement from **Room 1** to **Room 4** is the same as the distance travelled from **Room 1** to **Room 4**.'

Use calculations to explain why student **A** is incorrect.

....

....

....

.... **[2]**

(b) Draw **two** lines from each **word** to the correct **descriptions**.

Word	Descriptions
	Displacement / Time
Speed	Distance / Time
Velocity	Scalar
	Vector

[2]

(c) Student **B** runs along the corridor from **Room 1** to **Room 2**.

Fig. 11.2 is a graph of their motion:

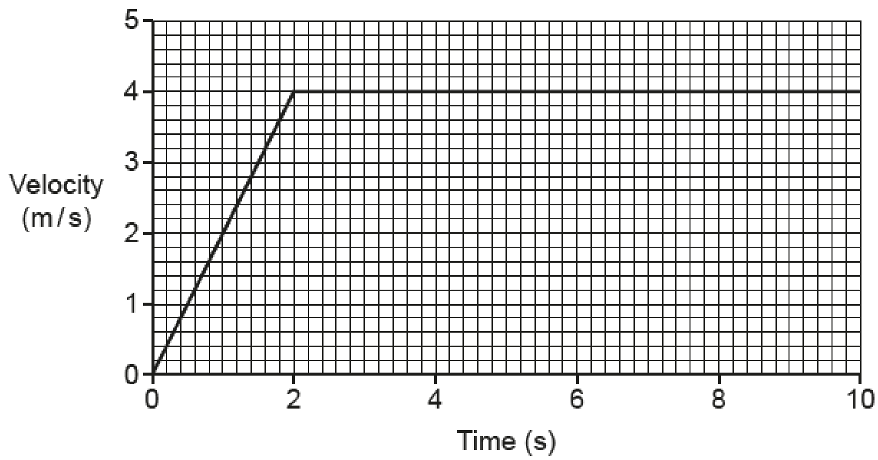


Fig. 11.2

(i) Calculate the acceleration of student **B** during the first 2 seconds.

Use the equation: acceleration = change in velocity/time

Acceleration = ... m/s^2 **[2]**

(ii) Describe the motion of the student between 2 and 10 seconds.

....

.... **[1]**

(iii) Student **C** starts running along the corridor from **Room 1** to **Room 2** at the same time as student **B**.

Their acceleration is **less** than student **B**'s acceleration.

Add a line to **Fig. 11.2** to show the acceleration of student **C**. **[1]**

4. Nov/2021/Paper_J250/05/No.12

Fig. 12.1 shows a picture of a ball on a field. The ball is not moving.

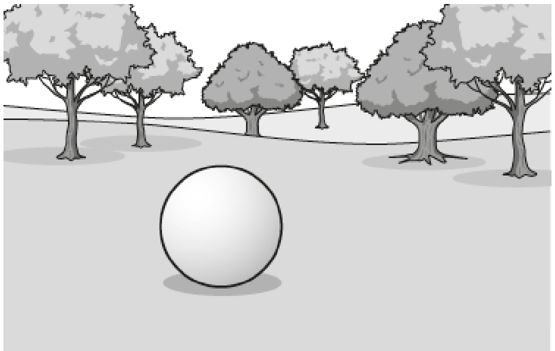


Fig. 12.1

(a) **Fig. 12.2** shows part of a free-body force diagram for the ball.

The force is drawn to scale. 1 cm = 1 N.

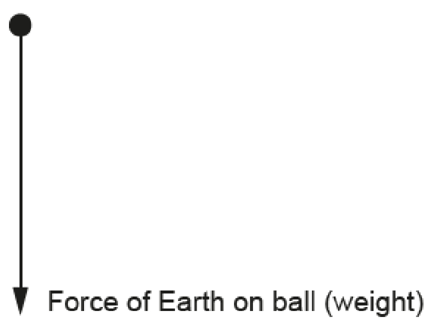


Fig. 12.2

(i) Complete the free-body force diagram by adding in the missing force. **[1]**

(ii) Which word describes this missing force?

Put a ring around the correct answer.

Contact **Electrostatic** **Gravity** **Magnetic**

[1]

(b) A person kicks the ball.

Complete the sentences explaining what happens to the ball.

Choose words from the list.

You may use each word once, more than once or not at all.

balanced

forces

gravity

masses

speed

unbalanced

The .... on the ball are ....

Therefore the .... of the ball changes.

[2]

(c) The mass of the ball is 0.4 kg.

How much force is needed to accelerate the ball at 400 m/s^2?

Use the equation: force = mass × acceleration

Force = ... N **[2]**

(d) **Fig. 12.3** shows the person placing the ball so it touches a wall.

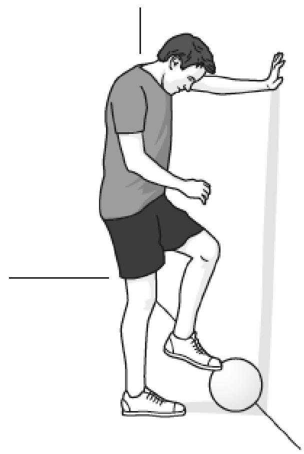


Fig. 12.3

He now kicks the ball directly at the wall.

The ball changes shape. Explain why.

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.... **[2]**

5. Nov/2021/Paper_J250/05/No.13

(a) A teacher lifts a weight of 45 N through a height of 1.8 m.

Calculate the work done by the teacher.

Use the equation: work done = force × distance

Work done = ... J **[2]**

(b) Another teacher does 1500 J of work.

They take 5 seconds to do the work.

Calculate their power.

Give the unit in your answer.

Use the equation: power = work done / time

Power = ... Unit .... **[3]**

6. Nov/2021/Paper_J250/05/No.14

A student carries out an experiment to calculate the spring constant of a spring.

Here are the student's results.

Mass (g)	Force (N)	Extension (m)	Spring constant (N/m)
100	0.98	0.05	20
200		0.11	18
300	2.94	0.15	20
400	3.92	0.21	19
500	4.91	0.25	

(a) Calculate the force when the mass is 200 g.

Use the equation: gravitational force = mass × gravitational field strength

Assume gravitational field strength = 10 N/kg.

Force = ... N **[3]**

(b) Calculate the spring constant when the mass is 500 g.

Use the equation: force exerted by a spring = extension × spring constant

Give your answer to the **nearest whole number**.

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

(c) Calculate the mean value of the spring constant.

Use the values in the table from 100 g to 400 g only.

Mean spring constant = ... N / m **[1]**

(d) The teacher says that calculating the mean is a poor method to find the spring constant, even though the student's calculations are correct.

Describe a better way to find the spring constant using the student's measurements.

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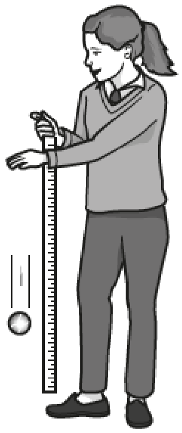
.... **[2]**

7. Nov/2021/Paper_J250/06/No.1

A student drops a ball from a height of 1 m. They measure the bounce height.



One of their results in the table is an outlier.

Attempt	1	2	3	4
Bounce height (cm)	54	56	52	38

Which result is the outlier?

A 38 cm

B 52 cm

C 54 cm

D 56 cm

Your answer ☐ **[1]**

8. Nov/2021/Paper_J250/06/No.8

A car of mass 1000 kg is travelling at 5 m/s.

Calculate the kinetic energy of the car.

Use the equation: kinetic energy = 0.5 × mass × $(\text{speed})^2$

A 2500 J

B 5000 J

C 12 500 J

D 25 000 J

Your answer ☐ **[1]**

9. Nov/2021/Paper_J250/06/No.9

Which row in the table explains why a safety belt is a safety feature in a car?

	Deceleration of driver	**Force on driver**
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Your answer ☐ **[1]**

10. Nov/2021/Paper_J250/06/No.10

Which factor increases **both** thinking distance **and** braking distance?

A Drinking alcohol

B Icy roads

C Increasing speed

D Worn tyres

Your answer ☐ **[1]**

11. Nov/2021/Paper_J250/06/No.12(a)

This question is about energy changes in different situations.

(a) A car moving at a constant speed has 60000 J of energy in its kinetic energy store. **Fig. 12.1** shows the change in the kinetic energy store and the thermal energy store as the car brakes, and after the car stops.

Fig. 12.1

(i) Define **braking distance**.

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.... **[1]**

(ii)
- The braking distance is 6 m.
- The thinking distance is 6 m.

Calculate the **stopping distance.**

Stopping distance = ... m **[1]**

12. Nov/2021/Paper_J250/06/No.14

Student **A** does an experiment to measure the reaction time of student **B**.

They use a 30 cm ruler. **Table 14.1** shows their method.

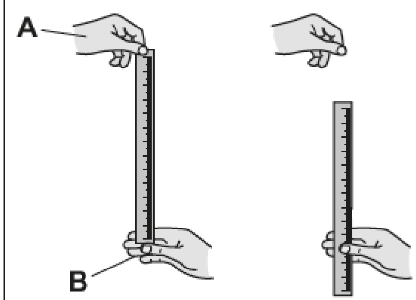
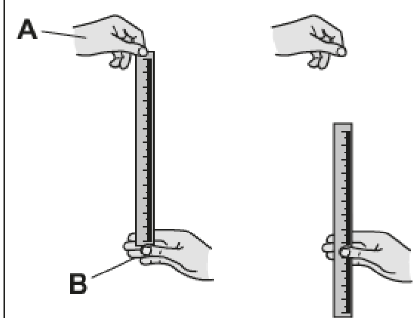
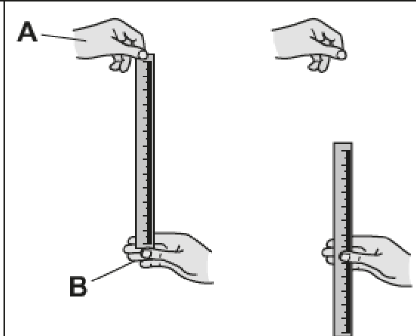
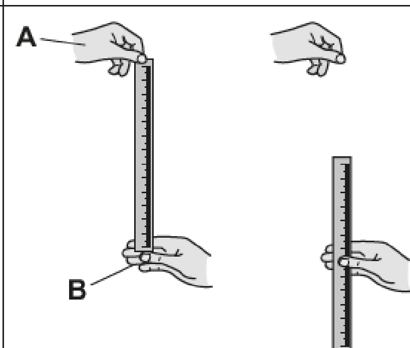
Test	**Time before dropping ruler (s)**	**Starting height of ruler above thumb of student B (cm)**	**How ruler was dropped**
1	2	0.0	
2	20	0.0	
3	5	0.0	
4	8	0.0	

Table 14.1

Describe how student **A** measures the reaction time of student **B**, **and** how the students obtain accurate and precise results.

Use the method shown in **Table 14.1** to support your answer.

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.... **[6]**

13. Nov/2020/Paper_J250/05/No.4

A man has a mass of 70 kg.

What is the weight of the man?

Use the equation: gravity force = mass × gravitational field strength

The gravitational field strength on Earth = 10 N / kg.

A 0.7 N

B 7 N

C 700 N

D 700 000 N

Your answer ☐ **[1]**

14. Nov/2020/Paper_J250/05/No.5

Vectors and scalars are different.

Which statement is correct?

A Speed has a direction. It is a vector.

B Speed only has size. It is a scalar.

C Velocity is a scalar and a vector.

D Velocity only has size. It is a scalar.

Your answer ☐ **[1]**

15. Nov/2020/Paper_J250/05/No.6

The unit of force is the newton (N). The unit of distance is the metre (m).

Which unit is the same as the newton-metre (Nm)?

Use the equation: work done = force × distance

A Joules (J)

B Kilograms (kg)

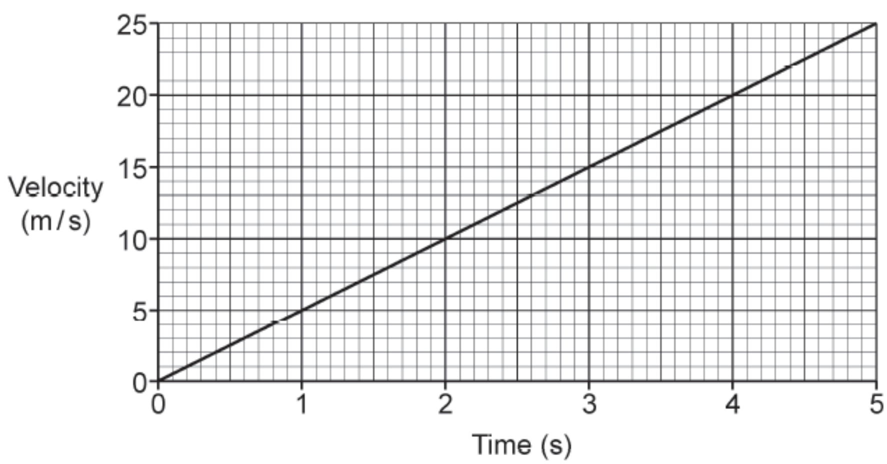
C Newtons per kilogram (N/kg)

D Watts (W)

Your answer [1]

16. Nov/2020/Paper_J250/05/No.8

This is a velocity-time graph for a car.



Calculate the acceleration of the car.

Use the equation: acceleration = change in velocity ÷ time

A $0.2\,m/s^2$

B $5\,m/s^2$

C $6\,m/s^2$

D $25\,m/s^2$

Your answer [1]

17. Nov/2020/Paper_J250/05/No.12

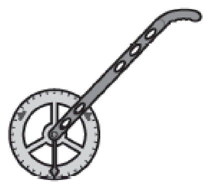
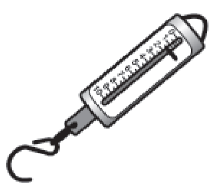
Two students, **P** and **Q**, are each calculating their mean speed when running 200 m.

One lap of a running track is 400 m.

(a) To be able to calculate their mean speed the students must use **two** pieces of apparatus and measure **two** quantities.

Draw lines to join the pictures to the correct name of the apparatus they should use.

Draw lines to join the name of the apparatus selected to the quantities they measure.

Picture of apparatus	**Name of apparatus**	**Quantities**
	30 cm ruler	Length of 200 m from the start.
	Trundle wheel	Time to start moving.
	Newton meter	Time to travel 200 m.
	Stopwatch	Length of 1 lap of the track.

[3]

(b) Student **P** makes three attempts at running 200 m. This is the results table showing the times achieved by student **P**.

First row →
Second row →

Time 1 (s)	Time 2 (s)	Time 3	Mean (s)
31	31.2	10.1	

(i) Look at the **first row** of the table.

What mistake has the student made?

.... **[1]**

(ii) Look at the **second row** of the table.

How many decimal places should the student have for **Time 1**?

.... **[1]**

(iii) Calculate the mean of the data in the table.

Mean = ... s **[1]**

(iv) Suggest what the student could do to improve their experiment.

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.... **[1]**

(c) This is part of the results table for student **Q** who runs 200 m.

Mean (s)
40

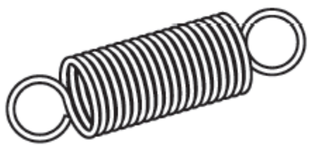
Calculate the mean speed of student **Q** running 200 m.

Use the equation: distance travelled = speed × time

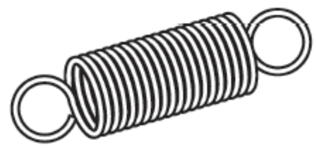
Mean speed = ... m/s **[3]**

18. Nov/2020/Paper_J250/05/No.16

A student is conducting an experiment by hanging some masses on two springs, **A** and **B**, and recording the extension.

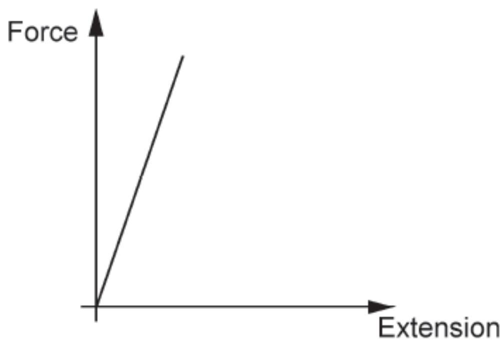


Spring **A** before the experiment

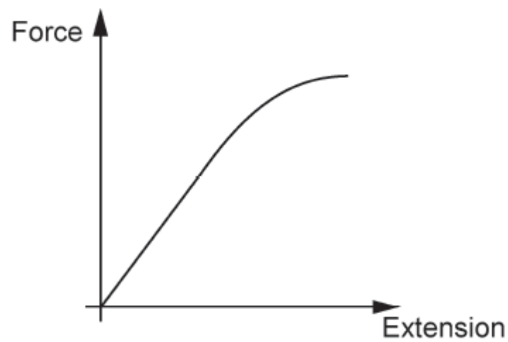


Spring **B** before the experiment

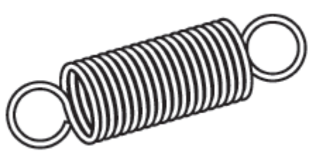
Here are graphs of his results:



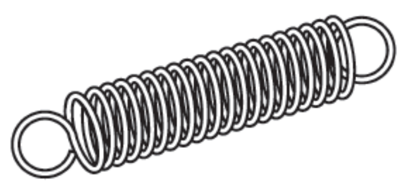
Spring **A**



Spring **B**



Spring **A** after the experiment



Spring **B** after the experiment

Use the graphs to describe the properties of spring **A** and spring **B**.

Write about Hooke's law in your answer.

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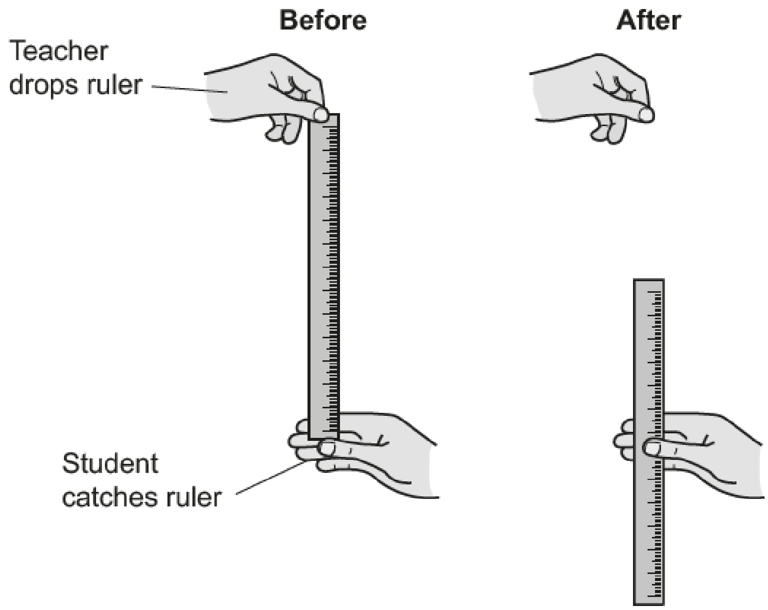
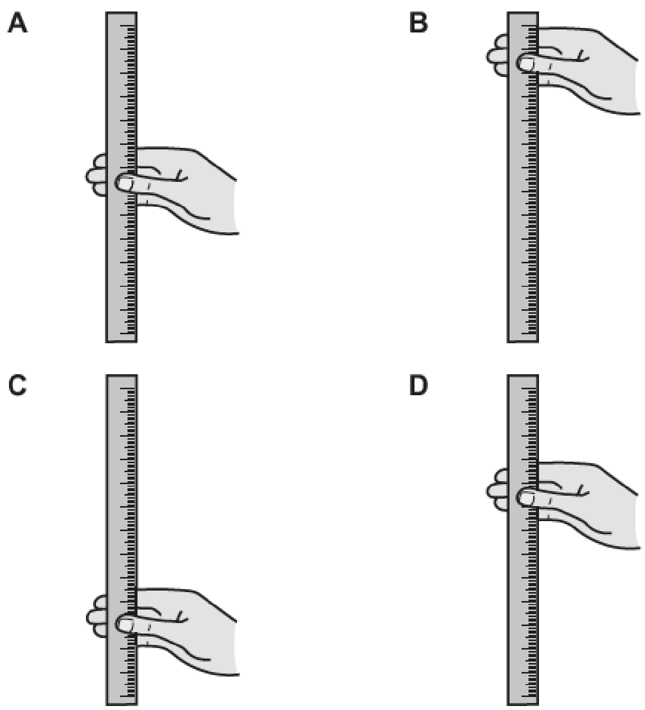
.... **[6]**

19. Nov/2020/Paper_J250/06/No.1

A ruler can be used to estimate a student's reaction time:



Which diagram shows the student with the **shortest** reaction time?



Your answer [1]

20. Nov/2021/Paper_J250/06/No.4

Stopping distance depends on thinking distance and braking distance.

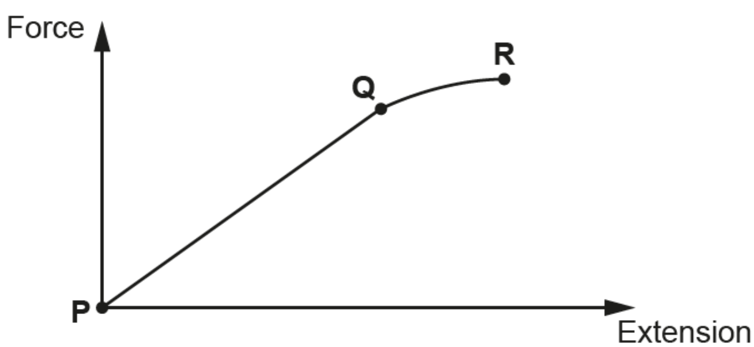
Which row in the table is correct?

	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
A	18	55	73
B	18	73	55
C	55	18	37
D	73	55	18

Your answer ☐ **[1]**

21. Nov/2021/Paper_J250/11/No.5

This is a force-extension graph for a spring.



Which statement is correct?

A Between **P** and **Q**, the graph is linear and obeys Hooke's law.

B Between **Q** and **R**, the graph is linear and obeys Hooke's law.

C The spring obeys Hooke's law and the graph is linear.

D The spring only obeys Hooke's law between **Q** and **R**.

Your answer ☐ **[1]**

22. Nov/2021/Paper_J250/11/No.9

This is a diagram of a collision between two cars.

The cars stick together in the collision.

Before collision		After collision
Mass = 1200 kg	Mass = 800 kg	Mass = 2000 kg
Velocity = 10 m/s	Velocity = 5 m/s	Velocity = ? m/s

Which statement is correct?

A The total momentum after the collision = 8 m/s.

B The total momentum after the collision = 64 000 J.

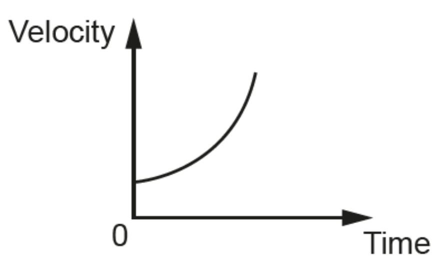
C The total momentum before the collision = 8 000 kg m/s.

D The total momentum before the collision = 16 000 kg m/s.

Your answer ☐ **[1]**

23. Nov/2021/Paper_J250/11/No.10

This is a velocity-time graph for an object.



Which statement describes the motion of the object?

A The object has a constant acceleration.

B The object is accelerating at a decreasing rate.

C The object is accelerating at an increasing rate.

D The object is decelerating.

Your answer ☐ **[1]**

24. Nov/2021/Paper_J250/11/No.12

(a) Explain **in words** what is meant by **power**.

....

.... **[1]**

(b) (i) A weightlifter lifts a 200 pound (200 lb) mass.

1 lb = 0.454 kg.

Calculate the weight of the mass in Newtons.

Use the equation: gravitational force = mass × gravitational field strength

Gravitational field strength = 10 N / kg.

Weight = ... N **[3]**

(ii) This is some data for a weightlifter.

Weight lifted	=	620 N
Height of the lift	=	1.6 m
Time taken to complete lift	=	4.0 s

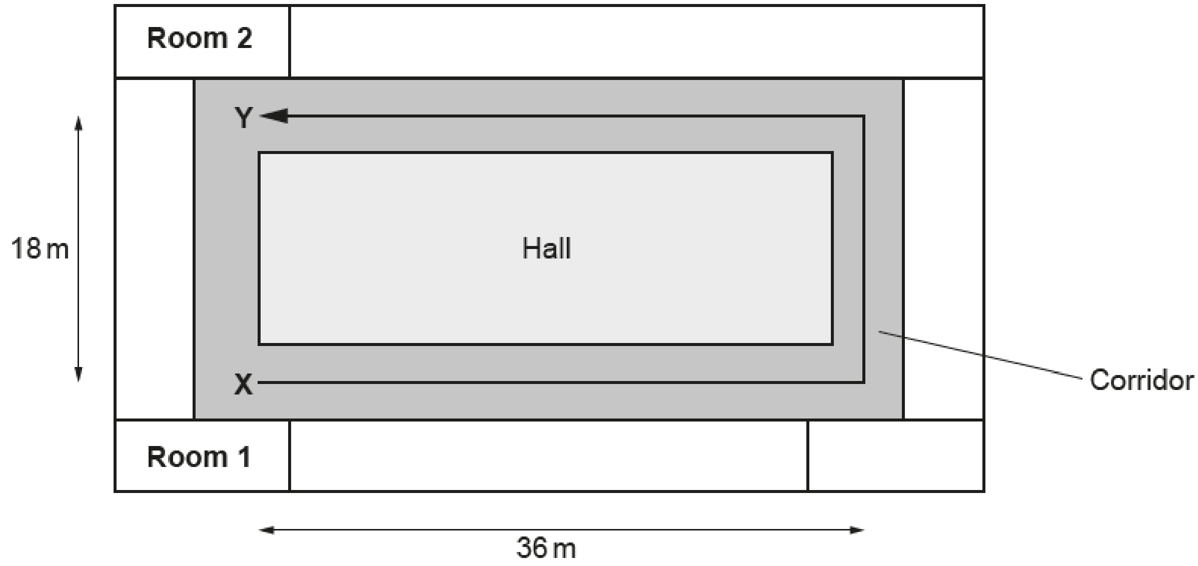
Calculate the power generated by the weightlifter.

Use the equations: work done = force × distance
power = work done / time

Power = ... W **[4]**

25. Nov/2021/Paper_J250/11/No.13

This is the plan view of a corridor in a school building.



The arrow **XY** shows the path student **A** takes to walk around the corridor from **Room 1** to **Room 2**.

Student **A** takes 120 seconds to walk from point **X** to point **Y**. Student **B** describes the motion:

'The average velocity of student **A** is greater than their average speed.'

'This is because their displacement is greater than the distance they travel.'

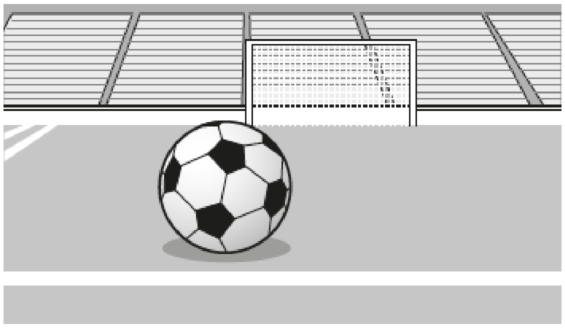
Evaluate these statements.

Use calculations to help explain your answer.

[6]

26. Nov/2021/Paper_J250/11/No.14

This is a picture of a ball on a field.



(a) Draw a free-body force diagram for the **ball**.

[2]

(b) **(i)** The ball is stationary on the field. Explain why using Newton's laws.

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.... **[1]**

(ii) Student **A** kicks the ball with their toes.

This hurts the student's toes. Explain why using Newton's laws.

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.... **[3]**

(c) **(i)** Student **A** kicks the ball.

Their boot is in contact with the ball for 0.05 s.

The velocity of the ball increases by 25 m/s.

Calculate the acceleration of the ball.

Use the equation: acceleration = change in velocity / time

Acceleration = ... m/s^2 **[2]**

(ii) Student **B** kicks the ball with a force of 216 N.

The mass of the ball is 0.45 kg.

Calculate the acceleration of the ball.

Use the equation: force = mass × acceleration

Acceleration = ... m/s^2 **[3]**

27. Nov/2021/Paper_J250/12/No.1

Which row in the table explains why a safety belt is a safety feature in a car?

	Deceleration of driver	Force on driver
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Your answer **[1]**

28. Nov/2021/Paper_J250/12/No.2

Which factor increases **both** thinking distance **and** braking distance?

A Drinking alcohol

B Icy roads

C Increasing speed

D Worn tyres

Your answer **[1]**

29. Nov/2021/Paper_J250/12/No.7

The speed of sound is greater than the speed of a person walking.

Estimate how many times greater.

A 10^2

B 10^4

C 10^6

D 10^8

Your answer **[1]**

30. Nov/2021/Paper_J250/12/No.12

Two students do an experiment to calculate their reaction times. They use a 30 cm ruler.

Describe, in detail, a suitable method the students can use to calculate reaction time using the ruler.

In your answer, include:

- Equations the students can use to calculate reaction time.
- How the students can obtain accurate and precise results.

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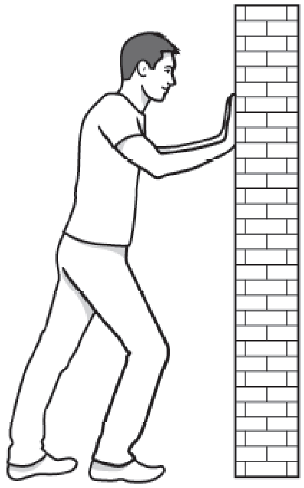
.... **[6]**

31. Nov/2020/Paper_J250/11/No.5

A man stands next to a wall. He exerts a force on the wall by pushing against the wall with both hands. His feet remain in the same place



Which statement is correct?

A Force of wall on man = 0.

B Force of wall on man < Force of man on wall.

C Force of wall on man = Force of man on wall.

D Force of wall on man > Force of man on wall.

Your answer ☐ **[1]**

32. Nov/2020/Paper_J250/11/No.9

A man weighs 700 N on Earth.

Estimate the weight of the man on the Moon.

Use the equation: gravity force = mass × gravitational field strength

The gravitational field strength on the Moon = 1.6 N/kg.

A 112 N

B 438 N

C 700 N

D 1120 N

Your answer ☐ **[1]**

33. Nov/2020/Paper_J250/11/No.10

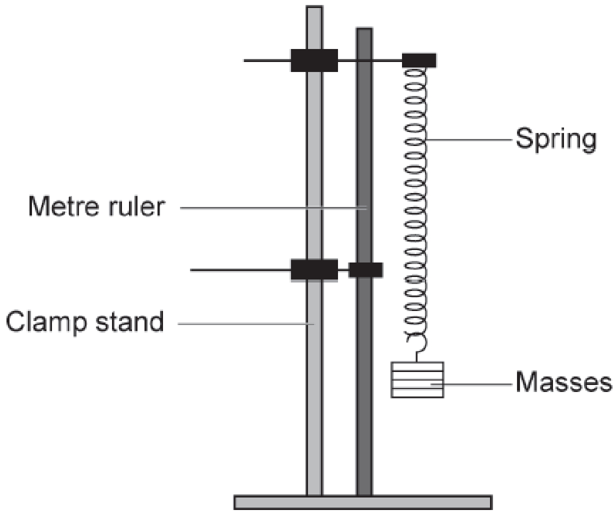
Which row of the table describes **inertia** and **mass**?

	Inertia	Mass
A	How difficult it is to change the velocity of an object.	Force ÷ acceleration
B	The momentum of an object at high speed.	Force × acceleration
C	The opposition of a circuit to a flow of charge.	Force ÷ acceleration
D	Using a force to transfer energy between stores.	Force × acceleration

Your answer ☐ **[1]**

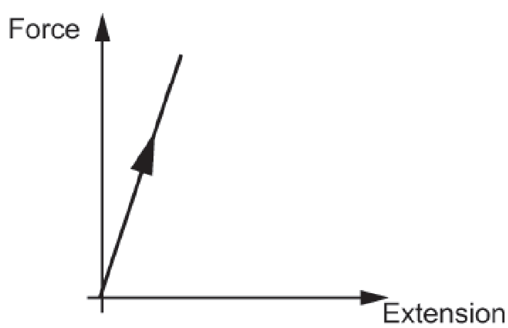
34. Nov/2020/Paper_J250/11/No.13

A student is doing an experiment by hanging some masses on two springs, **A** and **B**, and recording the extension.

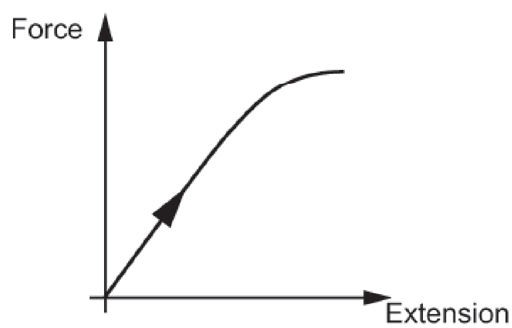


She measures the extension of each spring, after adding 100 g masses one by one.
She then measures the extension of each spring after removing the 100 g masses one by one.

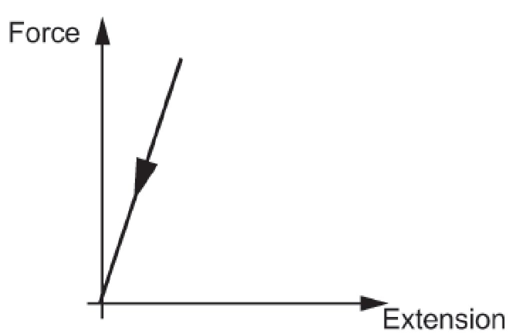
Here are the graphs of her results.



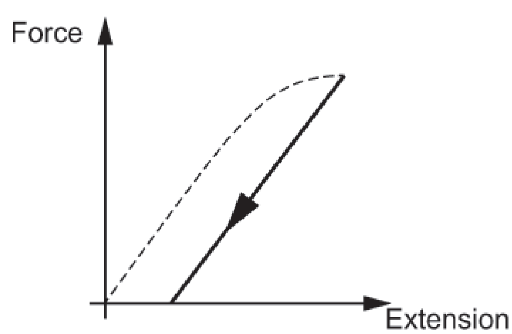
Adding masses to spring **A**



Adding masses to spring **B**



Removing masses from spring **A**



Removing masses from spring **B**

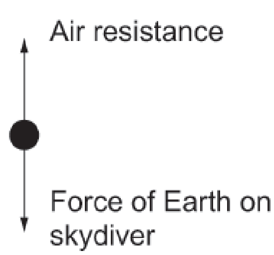
35. Nov/2020/Paper_J250/11/No.15

This question is about the motion of objects.

(a) A skydiver steps out of a plane.

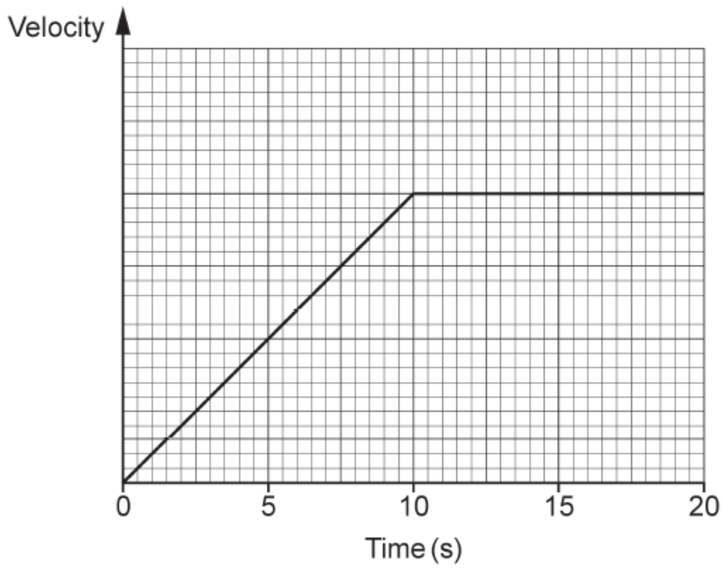
The table describes the motion of the skydiver at different times.

Complete the gaps in the table.

Situation	Free-body force diagram	Explanation
Skydiver steps out of plane and accelerates towards Earth.		
Acceleration of the skydiver decreases.		Air resistance increases with increasing velocity.
		Air resistance equals force of Earth on skydiver so there is no resultant force.

[3]

(b) Look at the velocity-time graph for a car during 20 seconds.



Overall, the car travels 390 m.

Use the graph to calculate the **final** velocity of the car.

Final velocity = ... m/s **[3]**

36. Nov/2020/Paper_J250/11/No.16

Some students investigate the speed of a trolley down a ramp.

The students do not have light gates, so instead they attach a tape to the trolley and release it down the ramp, as shown in **Fig. 16.1**.

They also set-up a machine with a timer to make a dot on the tape every 0.02 s.

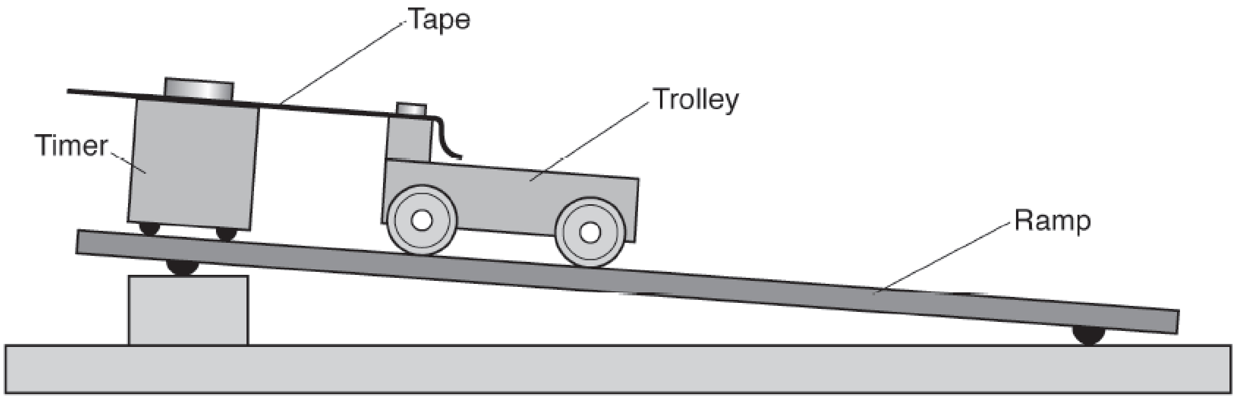


Fig. 16.1

(a) **Fig. 16.2** is part of the tape.

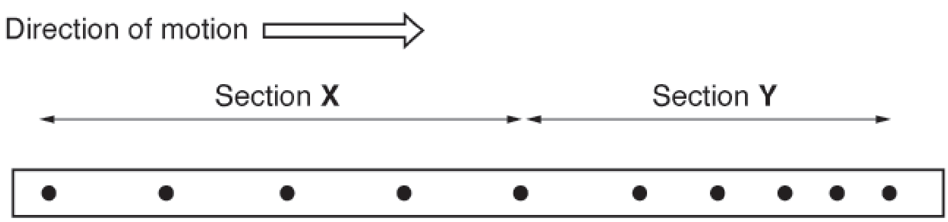


Fig. 16.2

Describe **and** explain the motion of the trolley in each section.

Section **X** ....

....

Section **Y** ....

....

[4]

(b) **Fig. 16.3** is part of another tape.

The timer for this tape also makes a dot on the tape every 0.02 s.

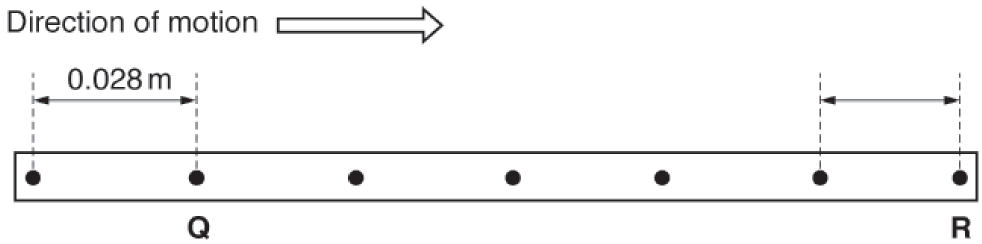


Fig. 16.3

(i) Use the tape in **Fig. 16.3** to calculate the speed of the trolley at point **Q**.

Use the equation: distance travelled = speed × time.

Speed at **Q** = ... m/s **[3]**

(ii) In a repeat experiment:

- the speed at **Q** is 1.3 m/s
- the speed at **R** is 1.0 m/s.

Use these values and the tape in **Fig. 16.3** to calculate the deceleration of the trolley.

Use the equation: deceleration = change in speed ÷ time.

Deceleration = ... m/s^2 **[3]**

37. Nov/2020/Paper_J250/12/No.1

Brakes are used to decelerate a car safely in order to reduce the risk of injuries to the passengers.

Which row in the table is correct when the brakes are used safely?

	Deceleration	Size of force on passengers
A	Large	Large
B	Large	Small
C	Small	Large
D	Small	Small

Your answer **[1]**

38. Nov/2020/Paper_J250/12/No.3

What is the typical value for human reaction time?

A 0.01 s

B 0.2 s

C 0.7 s

D 1.0 s

Your answer **[1]**

39. Nov/2020/Paper_J250/12/No.10

Thinking distance is directly proportional to speed.

The thinking distance at 30 mph is 9 m.

What is the thinking distance at 60 mph?

A 9 m

B 18 m

C 27 m

D 36 m

Your answer **[1]**