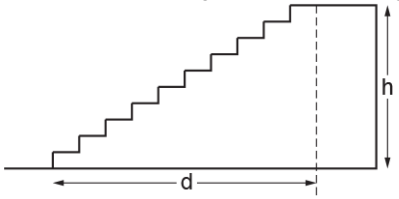
# Newton's Law (H)

**1.** A student of weight W runs up a flight of stairs.




She moves a distance d metres horizontally and h metres vertically.

What is the work done against gravity running up the stairs?

**A** W × d
**B** W × h
**C** (W × d) + (W × h)
**D** $W \times \frac{h}{d}$

Your answer ☐ **[1]**

**2.** Which statement is equivalent to the mass of an object?

**A** The ratio of acceleration over force
**B** The ratio of force over acceleration
**C** The ratio of velocity over acceleration
**D** The ratio of displacement over acceleration

Your answer ☐ **[1]**

**3.** A 2.0 kg object moves at a velocity of 40 m / s.

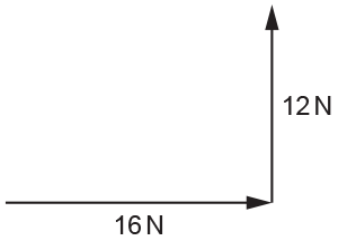
What is the momentum of the object?

Use the equation: momentum = mass × velocity

**A** 20 kg m / s
**B** 38 kg m / s
**C** 42 kg m / s
**D** 80 kg m / s

Your answer ☐ **[1]**

**4.** Two forces act at right angles to each other.



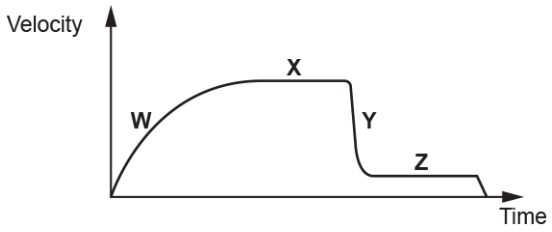

What is the magnitude of the resultant force?

**A** 18 N
**B** 20 N
**C** 22 N
**D** 24 N

Your answer ☐ **[1]**

**5.** A skydiver falls from a plane. His parachute opens and he lands safely.

Look at the velocity-time graph of his journey.




Which parts of the graph show balanced forces on the skydiver?

**A** **X** only
**B** **Y** and **Z**
**C** **X** and **Z**
**D** **Y** only

Your answer ☐ **[1]**

**6.** Which of the pairs are contact forces?

**A** Air resistance and gravity
**B** Friction and gravity
**C** Magnetism and normal contact force
**D** Normal contact force and air resistance

Your answer ☐ **[1]**

**7.** A student uses 2250 J of energy climbing up steps. It takes the student 15 seconds to climb the steps.

Calculate the power of the student.

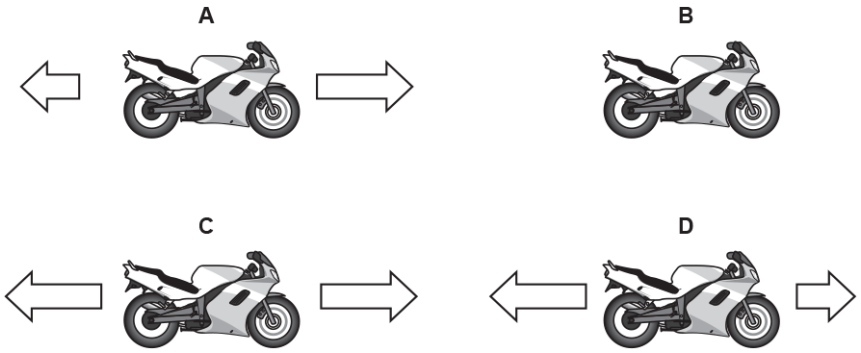
Use the equation: power = work done ÷ time taken

**A** 15 W
**B** 150 W
**C** 9000 W
**D** 33750 W

Your answer ☐ **[1]**

**8.** A motorbike travels along a straight flat road.

The arrows represent the horizontal forces acting on the motorbike.




Which motorbike is travelling at a uniform velocity?

Your answer ☐ **[1]**

**9.** Which statement is an example of Newton's third law?

**A** Doubling the engine force on a car doubles its acceleration.
**B** Doubling the engine force on a car halves its acceleration.
**C** When a ball is rolling on a table it continues rolling at a steady speed.
**D** When you clap your hands each hand experiences a force from the other hand.

Your answer ☐ **[1]**

**10.** A car on a roller coaster is stationary at the top of a slope.

It has a weight of 6 500 N and a potential energy of 217 000 J.

Calculate how high above the ground it is.

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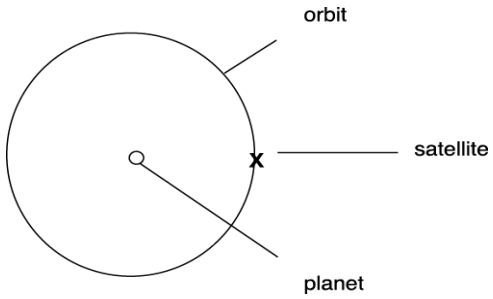
**answer:** ..... m
**[2]**

**11.** An artificial satellite (**X**) is kept in a stable circular orbit around a planet by a centripetal force caused by gravity.




**i.** Explain how the velocity of a satellite is constantly changing whilst its speed remains the same when it is in orbit.

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_____ **[2]**

**ii.** The satellite is remotely controlled from Earth.

The scientists want the satellite to move slower.

What effect will this change in speed have on the height of its orbit?

Explain your answer.

_____

_____ **[2]**

**12.** Cars and lorries have different brakes.

Brakes absorb the energy of the vehicle before it comes to rest.

The brakes on lorries have larger brake discs and brake pads than cars.

Brakes are designed for increased air flow.

Explain why this is more important for lorries than cars.

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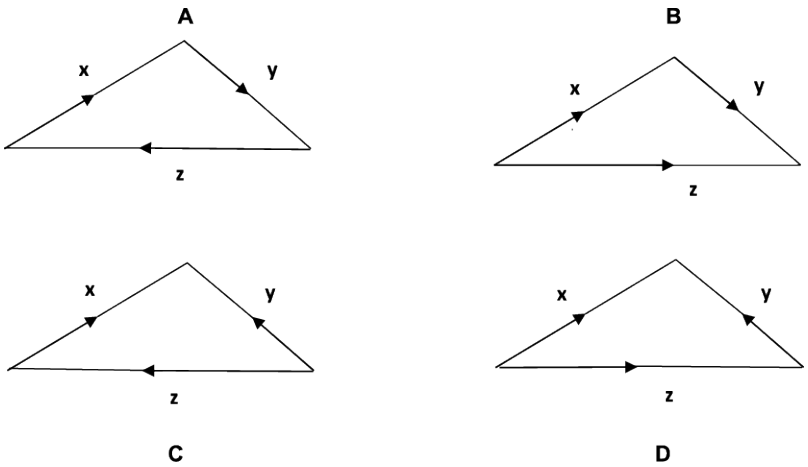
_____ **[4]**

**13.** A body has three forces, **x**, **y** and **z** acting on it.

The body is in **equilibrium**.

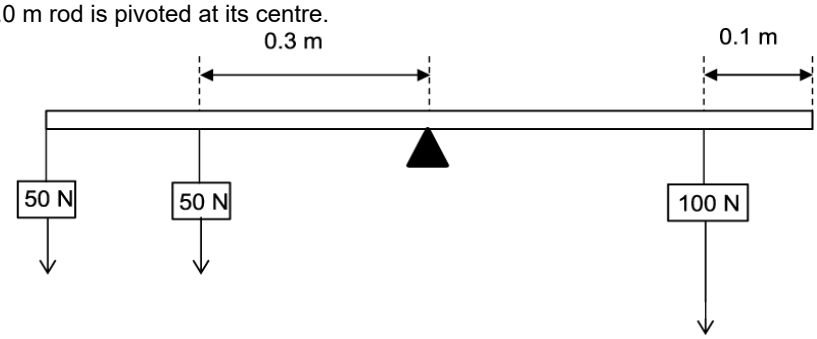
Which vector diagram represents this situation?




Your answer ☐

**[1]**

**14.** 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]**

**15.** A car and driver with a total mass of 1000 kg is travelling at 20 m/s.

The driver applies the brake and the car comes to a stop in 4 seconds.

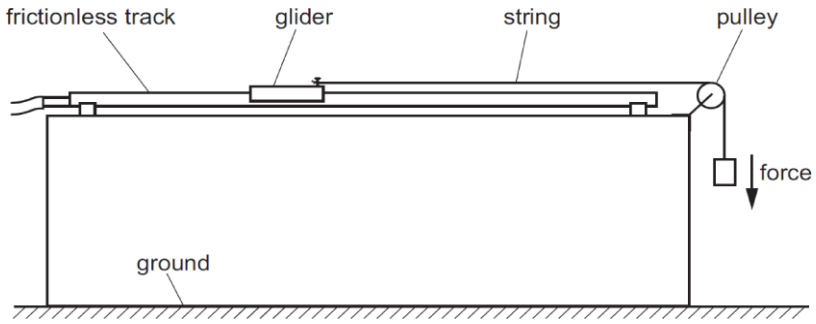
What is the mean force on the car?

**A.** 80 000 N
**B.** 5 000 N
**C.** 200 N
**D.** 12.5 N

Your answer ☐

**[1]**

**16 (a).** A student investigates the motion of a glider on a frictionless air track using the apparatus shown in the picture.




**i.** Explain how the student can use this apparatus to demonstrate Newton's Second Law.

Include details of any additional equipment required.

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**[3]**

**ii.** A 0.25 kg glider is pulled by a 1.0 N force.

Calculate the acceleration of the glider using the formula:

**force = mass × acceleration**

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**answer:** ..... m/s$^2$

**[1]**

**iii.** Suggest reasons why the recorded value was less than your calculated value.

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**[2]**

**(b).** The student carries out the experiment for 5 forces

| Force (N) | Acceleration (m/s$^2$) | | | |
|---|---|---|---|---|
| | **Attempt 1** | **Attempt 2** | **Attempt 3** | **Mean** |
| 1.0 | 3.8 | 3.9 | 3.7 | 3.8 |
| 2.0 | 7.8 | 7.7 | 7.7 | 7.7 |
| 3.0 | 11.2 | 11.4 | 11.6 | 11.4 |
| 4.0 | 12.0 | 14.9 | 15.1 | 13.8 |
| 5.0 | 19.0 | 18.9 | 19.1 | 19.0 |

There is an anomaly in the results.

Identify the anomaly and explain how the student could have dealt with it.

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**[2]**

**(c).** Explain what is meant by a reproducible experiment.

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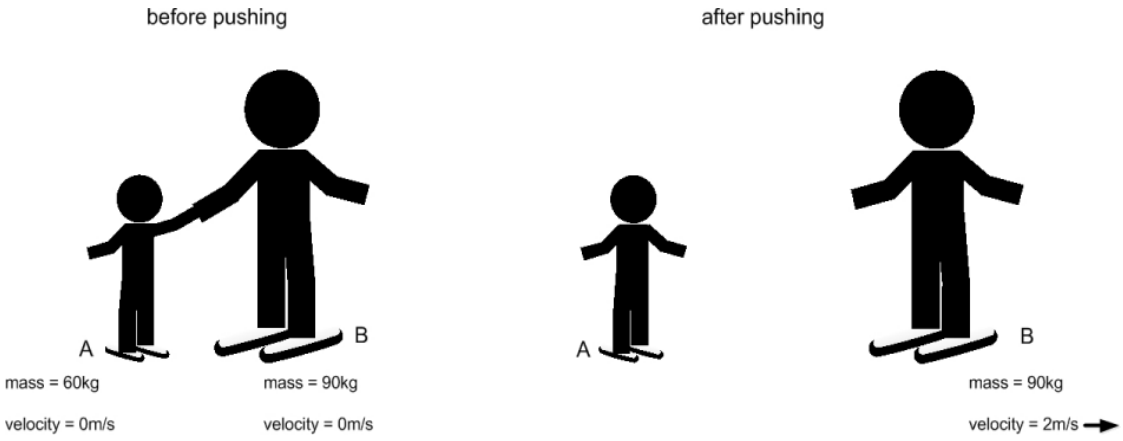
**[1]**

**17 (a).** Two ice skaters A and B, at rest, start together on the ice.

The ice skaters push apart and they move off in opposite directions.




State the law of conservation of momentum.

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**[1]**

**(b).** Use the data and your knowledge of momentum to calculate the velocity of skater **A** after pushing.

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**[2]**

**18.** A student researches potential and kinetic energy. She looks at some data from experiments with motion trolleys and energy.

The trolleys are stationary at the top of the ramp and have a gravitational potential energy of 8 J.

Each trolley has a mass of 1 kg.

Look at the research data on the trolleys.

| Trolley | Velocity at the bottom of the ramp (m/s) |
|---|---|
| W | 3 |
| X | 4 |
| Y | 5 |
| Z | 6 |

The student thinks the data is wrong.

Use the data and your understanding of energy transfer to justify why trolley W has the most likely velocity and why X, Y and Z do not.

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_____ **[4]**

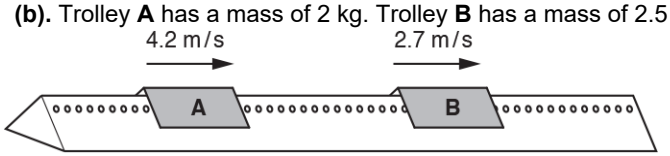
**19(a).** A student investigates collisions of trolleys on a horizontal airtrack.

Write down the **two** quantities involved with motion which are conserved during an elastic collision.

_____

_____ **[2]**

**(b).** Trolley **A** has a mass of 2 kg. Trolley **B** has a mass of 2.5 kg.




**i.** Calculate the **momentum** of each trolley.

Trolley **A** = ..... kg m/s
Trolley **B** = ..... kg m/s
**[3]**

**ii.** The two trolleys collide and stick together after the collision. Use your answers to **(i)** to calculate the **speed** of the combined trolleys after the collision.

Record your answer to **2** significant figures.

Answer = ..... m/s **[3]**

**20.** A student wants to find out the depth of a well.

She thinks that she can calculate this by dropping a stone into the well and timing how long it takes to hear the stone splash at the bottom.

Describe the motion of the stone as it falls.

Assume it does not reach terminal velocity.

Use a free body diagram to help you.

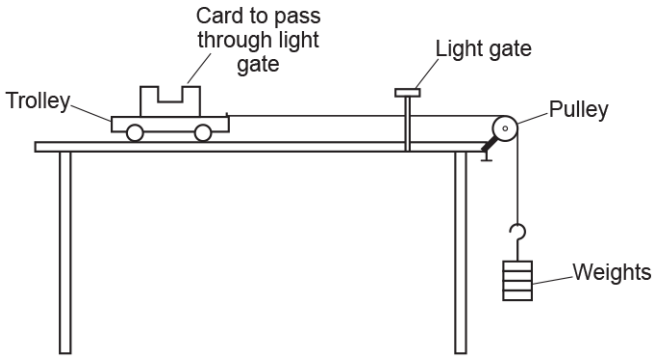
**[4]**

**21.** A student puts a small load on a spring. It is in equilibrium.

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

**[3]**

**22.** A student investigates the acceleration of a trolley.




The trolley is released from a fixed position and accelerates.

i. Describe the energy transfer as the trolley accelerates on the desk.

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**[1]**

ii. The trolley moves a distance of 86 cm along the desk.

Calculate the work done when a force of 3.0 N is applied.

Use the equation: work done = force × distance

Give your answer to **2** significant figures.

Work done = ..... J **[4]**

**END OF QUESTION PAPER**