

Mechanics

Question Paper

Level	Pre U
Subject	Physics
Exam Board	Cambridge International Examinations
Topic	Mechanics
Booklet	Question Paper

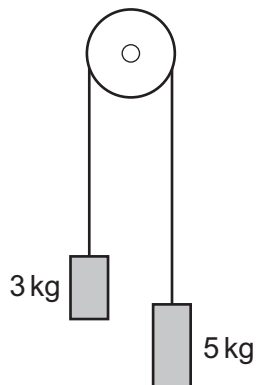
Time Allowed: 57 minutes

Score: /47

Percentage: /100

Grade Boundaries:

- 1 Two masses are connected by a weightless cord, which passes over a frictionless pulley. The masses are held stationary and then released.



The acceleration due to gravity is g .

What is the magnitude of the acceleration of the masses?

- A** $\frac{g}{4}$ **B** $\frac{3g}{8}$ **C** $\frac{5g}{8}$ **D** g
- 2 A water cannon directs a jet of water towards a vertical wall. Each minute, 300 kg of water hits the wall. The water hits the wall horizontally with a velocity 20 m s^{-1} . Assume the water falls vertically after hitting the wall.

What force does the water exert on the wall?

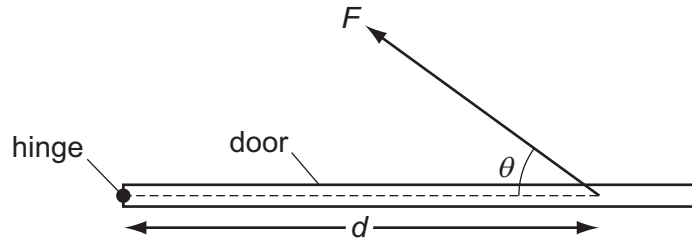
- A** 100 N **B** 200 N **C** 3000 N **D** 6000 N

Space for working

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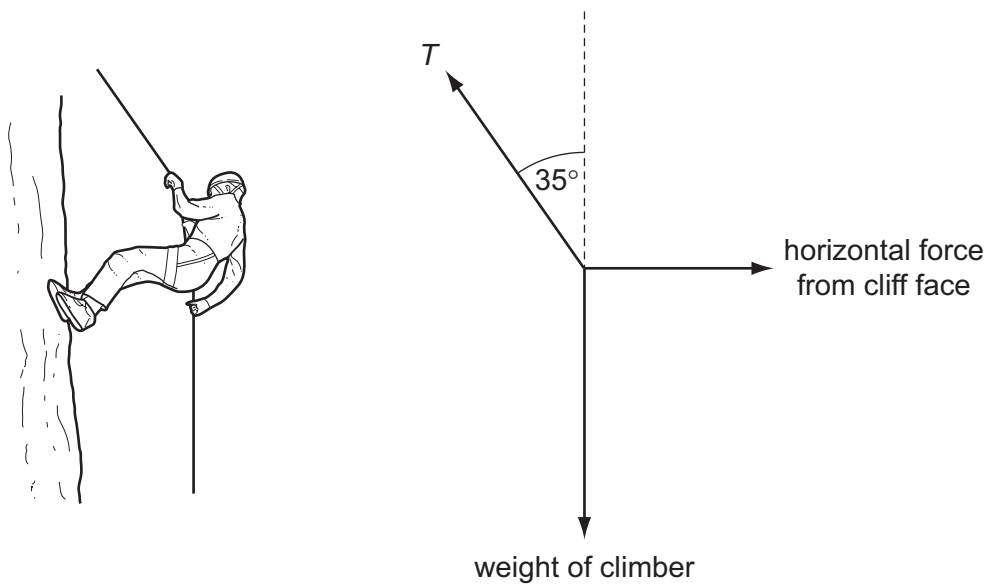
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- 3 A force F is applied to a door at an angle θ , at a distance d from the hinge.



What is the moment of F about the hinge?

- A $Fd\sin\theta$ B $\frac{Fd}{\sin\theta}$ C $Fd\cos\theta$ D $\frac{Fd}{\cos\theta}$
- 4 A rock climber descends a cliff face by abseiling.



The mass of the climber is 64 kg.

The climber stops descending and holds the rope under tension at an angle of 35° to the vertical.

What is the magnitude of the horizontal force exerted on the climber from the cliff face?

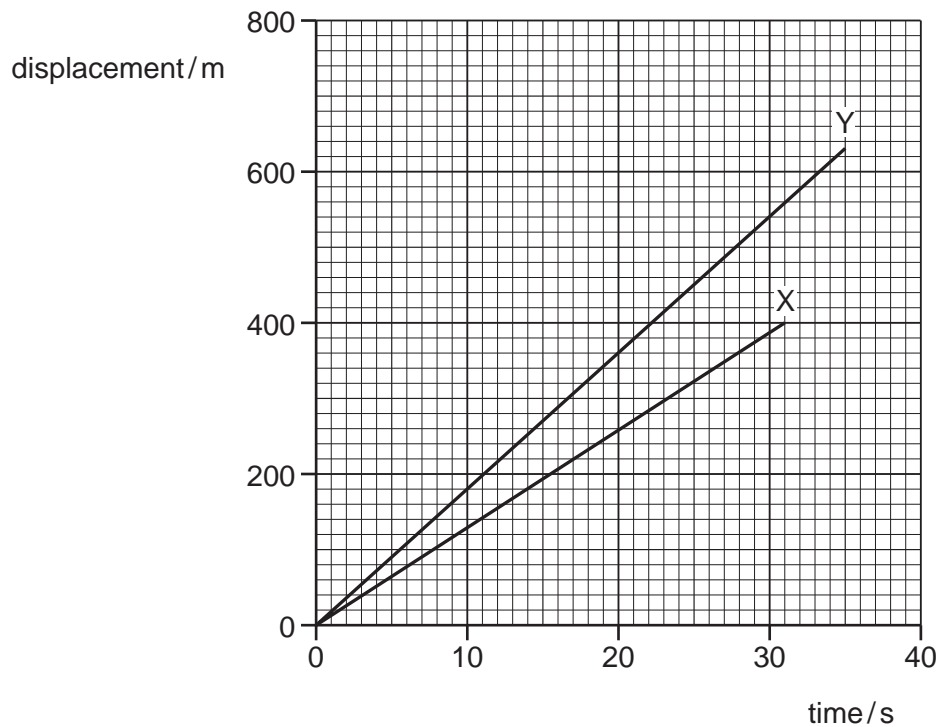
- A 300 N B 360 N C 440 N D 510 N

Space for working

5 Which row contains one vector quantity and one scalar quantity?

- A acceleration, velocity
- B displacement, force
- C length, weight
- D mass, time

6 A displacement-time graph is plotted for two lifts, X and Y.

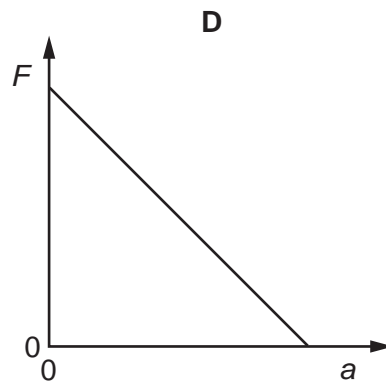
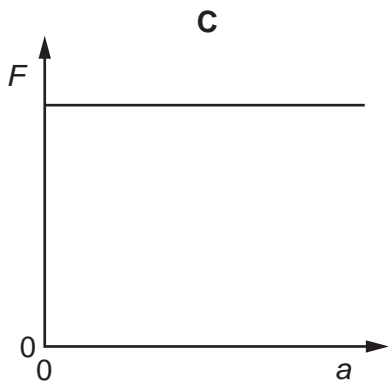
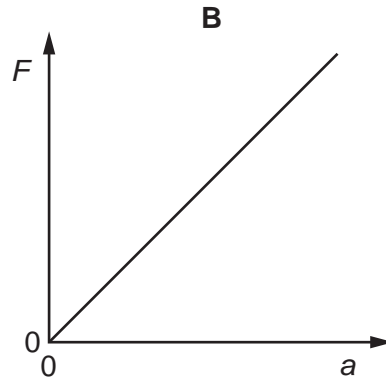
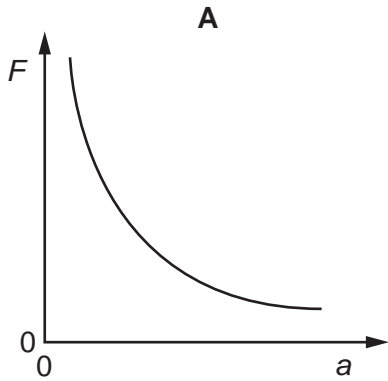


What is the value of the ratio $\frac{\text{lift X velocity}}{\text{lift Y velocity}}$?

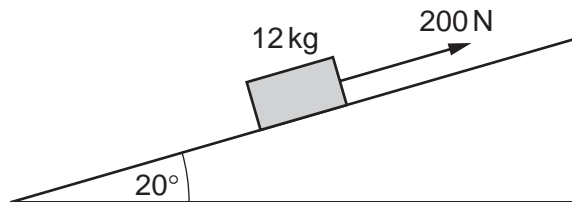
- A 0.6
- B 0.7
- C 1.4
- D 1.6

Space for working

- 7 Which graph shows the relationship between the resultant force F acting on an object and the acceleration a of the object? Assume that mass of the object does not change.



- 8 An object of mass 12 kg is pulled up a smooth inclined plane by a force of 200 N parallel to the plane. The plane is at an angle of 20° to the horizontal.



What is the resultant force on the object?

- A** 110 N **B** 160 N **C** 196 N **D** 200 N

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- 9 A ball is thrown vertically downwards at 4.0 m s^{-1} from a height of 120 cm.
With which speed does it hit the ground? Ignore air resistance.

A 4.8 m s^{-1} **B** 6.3 m s^{-1} **C** 40 m s^{-1} **D** 49 m s^{-1}

- 10 Which statement about collisions is correct?

A In an inelastic collision, momentum may not be conserved.
B In any collision, kinetic energy is conserved.
C In any collision of two or more objects, the total momentum before and after cannot be zero.
D In any collision, total momentum is conserved.

- 11 A projectile of mass 10 kg is fired at 20 m s^{-1} at an angle of 30° to the horizontal.

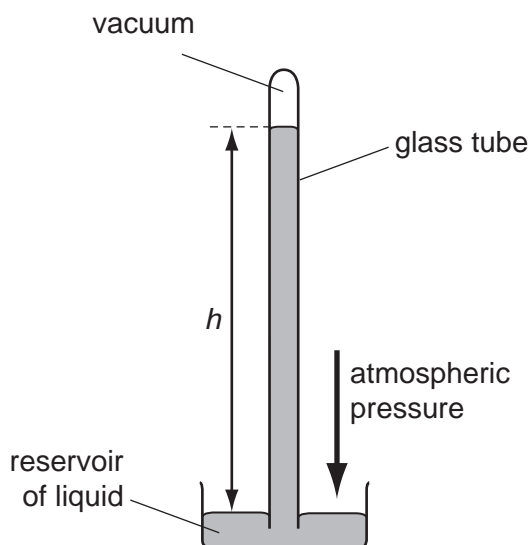


What is its kinetic energy at the top of its flight?

A 0 J **B** 500 J **C** 1500 J **D** 2000 J

Space for working

- 12 A barometer can be used to measure atmospheric pressure as shown.



The pressure of the column of liquid exerted on the reservoir surface is equal to the atmospheric pressure.

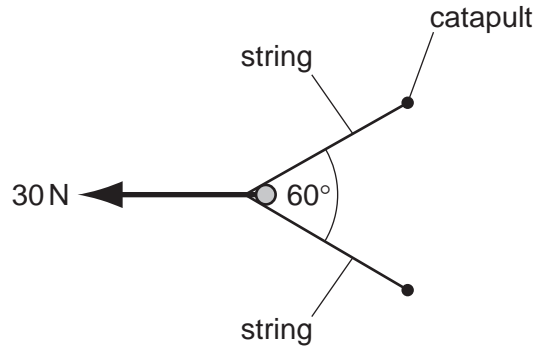
For a barometer containing water the height h is 10.4m. A second barometer, with a glass tube which has twice the cross-sectional area, contains alcohol.

density of water = $1.0 \times 10^3 \text{ kg m}^{-3}$
density of alcohol = $0.8 \times 10^3 \text{ kg m}^{-3}$

What is the height h of the alcohol?

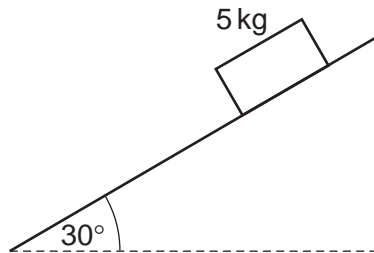
- A** 4.2m **B** 6.5m **C** 8.3m **D** 13m

- 13 A force of 30 N is required to pull the strings of a catapult into the firing position.



What is the tension in each string?

- A** 15 N **B** 17 N **C** 30 N **D** 35 N
- 14 A wooden block of mass 5 kg is released on a smooth inclined plane.



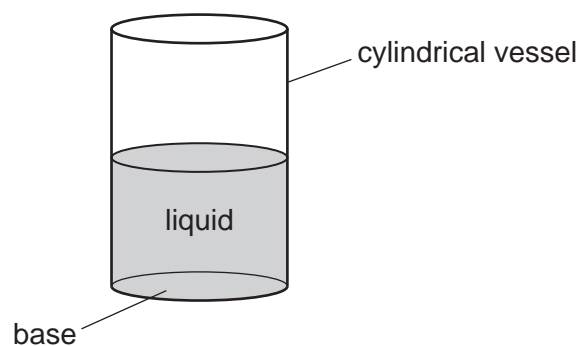
The acceleration due to gravity is given by g .

What is the acceleration of the block down the inclined plane?

- A** $\frac{g}{5}$ **B** $\frac{g}{2}$ **C** $g\sqrt{\frac{3}{2}}$ **D** g

Space for working

- 15 A cylindrical vessel stands upright on its base of cross-sectional area A . It contains a volume V of a liquid with density ρ .

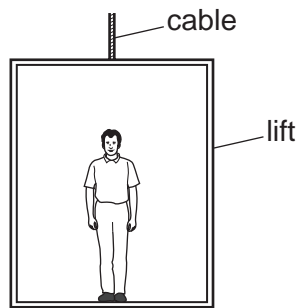


Which combination will produce the same pressure at the bottom of the liquid?

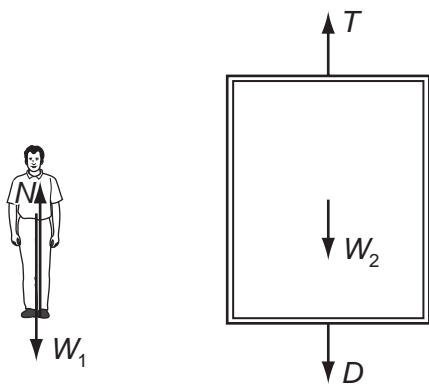
	cross-sectional area	density	volume
A	$\frac{A}{2}$	2ρ	V
B	$\frac{A}{2}$	$\frac{\rho}{2}$	$2V$
C	$2A$	2ρ	V
D	$2A$	$\frac{\rho}{2}$	$2V$

Space for working

- 16 The diagram shows a man standing in a lift.



The forces acting on the man and the forces acting on the lift are shown below.



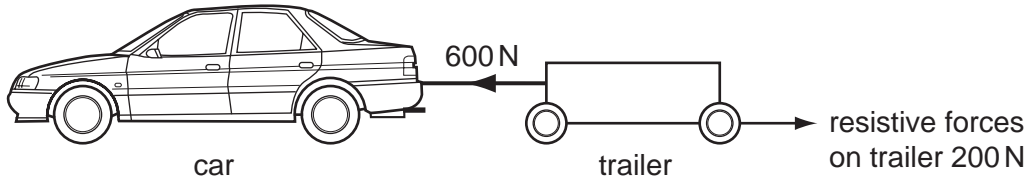
N is the force from the lift floor on the man.
 W_1 is the weight of the man.
 T is the tension in the lift cable.
 W_2 is the weight of the lift.
 D is the force from the man on the lift floor.

Which statement is correct?

- A N and W_1 are always equal and opposite.
- B $(W_1 + W_2)$ is always equal to T .
- C If $N = W_1$ the lift must be at rest.
- D If $T = (D + W_2)$ the lift must have a constant velocity.

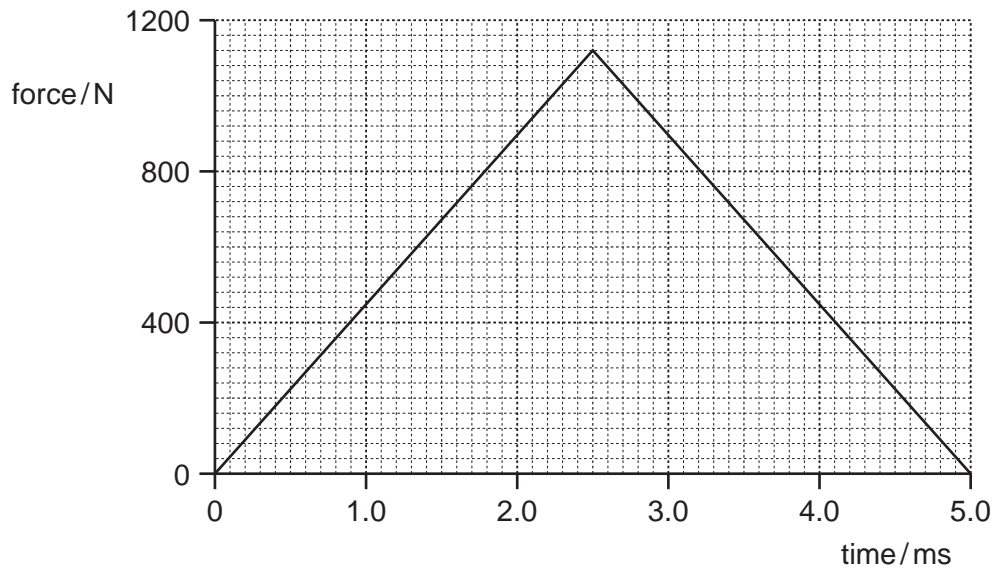
Space for working

- 17 A trailer of mass 400 kg is pulled by a car of mass 1200 kg. The diagram shows the horizontal forces acting on the trailer.



What is the unbalanced force acting on the car?

- A** 400 N **B** 600 N **C** 1200 N **D** 1800 N
- 18 A tennis ball of mass 56 g is struck by a tennis racquet. The graph shows how the force exerted on the ball by the racquet varies with time.

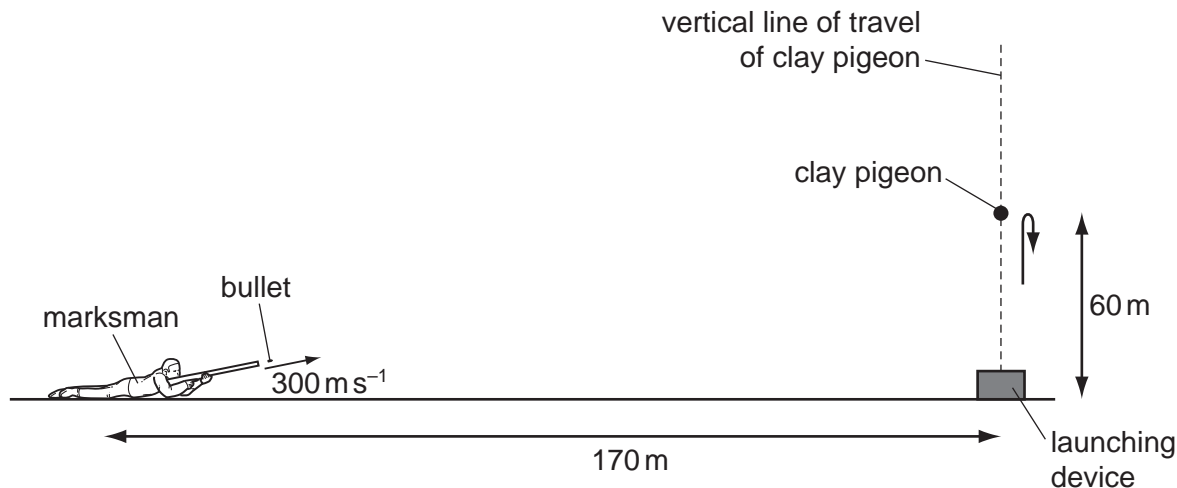


What is the change in the velocity of the tennis ball?

- A** 50 cm s⁻¹ **B** 100 cm s⁻¹ **C** 50 m s⁻¹ **D** 100 m s⁻¹

Space for working

19 A clay pigeon is launched vertically into the air from the ground.



(diagram not to scale)

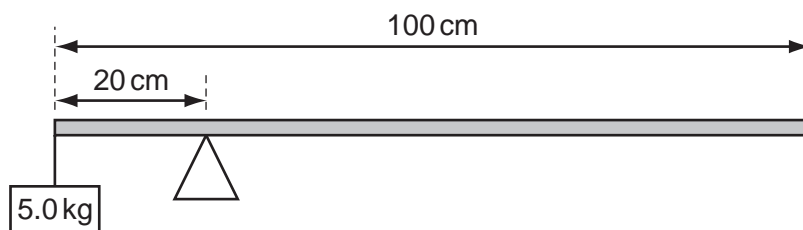
A marksman lies 170 m away from the launching device on level ground. Just as the clay pigeon reaches its maximum height of 60 m , the marksman fires a bullet aimed directly at the clay pigeon. The bullet leaves the rifle with a speed of 300 m s^{-1} .

At what time after the bullet is fired is the clay pigeon hit? Assume air resistance is negligible.

- A 0.17 s
- B 0.57 s
- C 0.60 s
- D 1.66 s

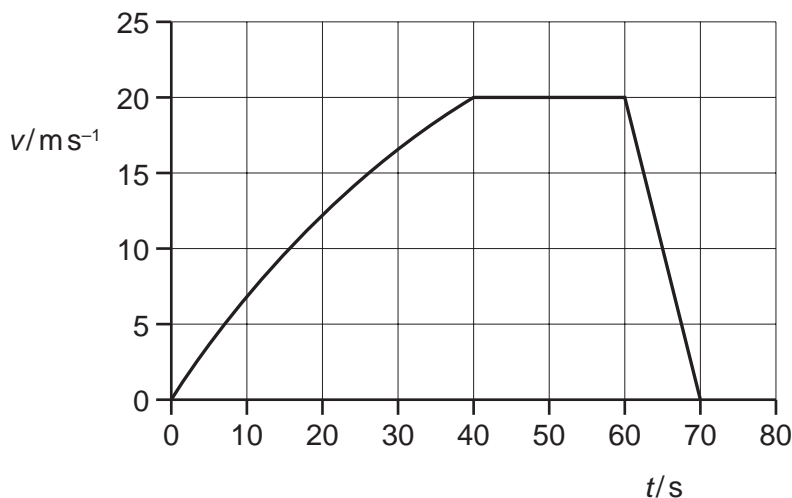
Space for working

- 20 The diagram shows a uniform beam of length 100 cm pivoted 20 cm from one end and balanced with a 5.0 kg mass.



What is the mass of the beam?

- A** 1.00 kg **B** 1.25 kg **C** 3.3 kg **D** 5.0 kg
- 21 An object starts from rest at time $t = 0$ and moves in a horizontal straight line. The graph shows how the velocity v of the object varies with time.



What is the distance travelled by the object during the time that its acceleration is zero?

- A** 300 m **B** 400 m **C** 800 m **D** 1200 m
- 22 A body is initially at rest. Two forces are then applied to it; one is constant, the other acts in the opposite direction with a magnitude that is proportional to the velocity of the object.
- Which statement best describes the motion of the object?
- A** The acceleration will increase from zero to a maximum.
B The acceleration will increase from zero to a maximum and then decrease.
C The velocity will increase from zero to a maximum.
D The velocity will increase from zero to a maximum and then decrease.

- 23 In the 2009 World Championships in Berlin, Usain Bolt won the 100 m in a new world record time of 9.58 s. Bolt was so far in front of the other runners that he began to slow down and celebrate before the end of the race.

The table shows his times for each successive 20 m section of the race.

distance (m)	time (s)
0-20	2.74
20-40	1.75
40-60	1.67
60-80	1.61
80-100	1.66

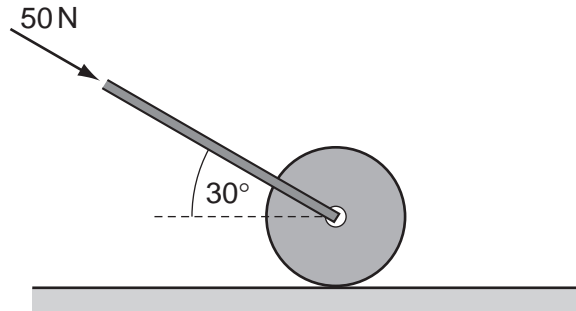
Usain Bolt's reaction time at the start of the race was 0.15 s.

Which time would he have achieved if his reaction time had been 0.12 s **and** if he had not slowed down after reaching his maximum velocity?

- A** 9.50 s **B** 9.51 s **C** 9.53 s **D** 9.56 s

Space for working

- 24 A heavy roller is pushed across a horizontal grass surface.
A force of 50 N is needed to push it at a steady velocity of 0.50 m s^{-1} .



How much work is done on the roller when it is pushed for 10 s?

- A** 130 J **B** 220 J **C** 250 J **D** 870 J
- 25 A car pulls a trailer of mass 500 kg. The friction acting on the car is 1200 N and that on the trailer is 400 N. At first, the acceleration of the car and trailer system is 2 m s^{-2} .
- What is the tension in the coupling between the car and trailer for this acceleration?
- A** zero **B** 1400 N **C** 1800 N **D** 2600 N

Space for working

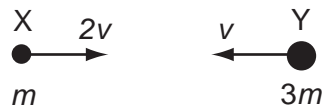
- 26 A helicopter is moving horizontally at 60 m s^{-1} at a height of 80 m above level ground. The pilot aims to land a parcel at position X shown in the diagram.



At what horizontal distance from X should the parcel be dropped? Ignore air resistance.

- A** 0 m **B** 72 m **C** 240 m **D** 960 m
- 27 An object X, of mass m , is travelling to the right at speed $2v$.

A second object Y, of mass $3m$, is travelling to the left at speed v .



The two objects collide, head on, in an inelastic collision.

Which of the following is a possible outcome after the collision?

	X	Y
A	0	0
B	$\leftarrow \frac{v}{3}$	$\frac{v}{3} \rightarrow$
C	$\leftarrow \frac{v}{2}$	$v \rightarrow$
D	$\leftarrow 2v$	$\frac{v}{3} \rightarrow$

Space for working

28 A swimmer dives off a diving board into a pool.

Which quantity will **not** affect the time she spends in the air before hitting the water?

- A acceleration due to gravity
- B air resistance
- C her horizontal velocity on leaving the board
- D the height of the board

Space for working

29 A student is studying Newton's third law of motion. He states that a rocket travelling in deep space can never accelerate because when the rocket's engines burn, the forwards force acting on the rocket is cancelled by an equal and opposite force.

Which statement explains why the student is wrong?

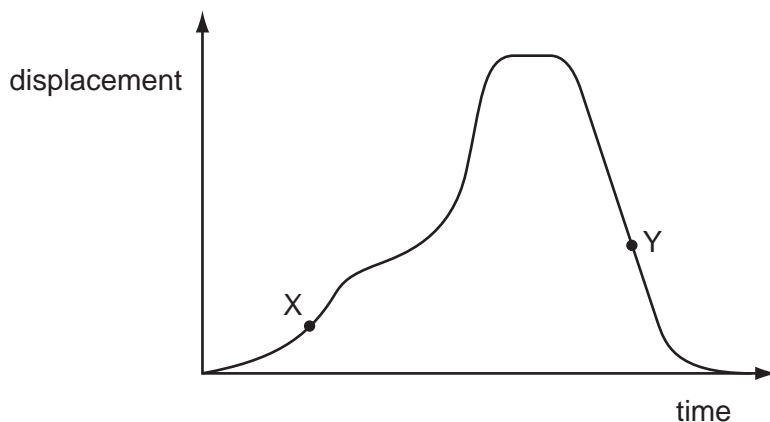
- A The equal and opposite force does not act on the rocket.
- B The equal and opposite force has a different line of action.
- C The equal and opposite force is a reaction force.
- D The equal and opposite force will be a different type of force.

- 30 A water cannon directs a jet of water towards a vertical wall. 300 kg of water hit the wall each minute. The water hits the wall horizontally with a velocity 20 m s^{-1} . Assume the water falls vertically after hitting the wall.

What force does the water exert on the wall?

- A** 100 N **B** 200 N **C** 3000 N **D** 6000 N

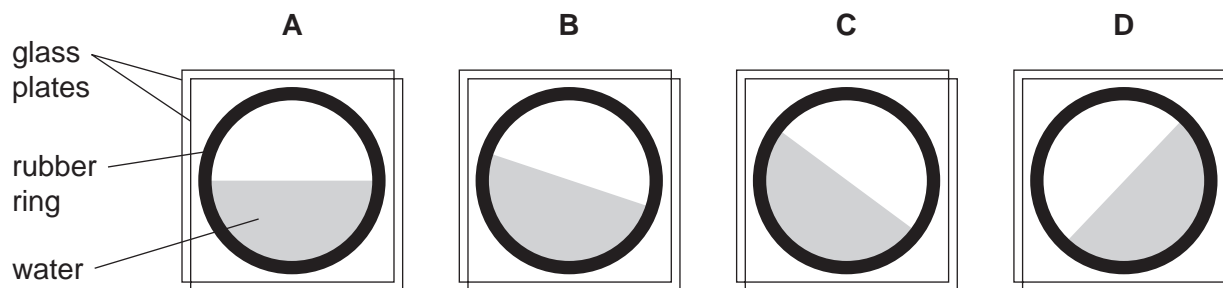
- 31 The graph shows how the horizontal displacement of a fairground car changes with time for part of its journey.



A simple accelerometer is made by sandwiching a rubber ring between two glass plates and introducing some coloured water inside the ring. The accelerometer is attached to the side of the car.

Diagram **B** corresponds to point X on the graph.

Which diagram shows the angle of water surface in the accelerometer at point Y?



Space for working

- 32 A particle moves with constant speed in a circle of radius r under the action of a constant force of magnitude F .

What is the work done by the force in one complete revolution of the particle?

A Fr

B $2\pi Fr$

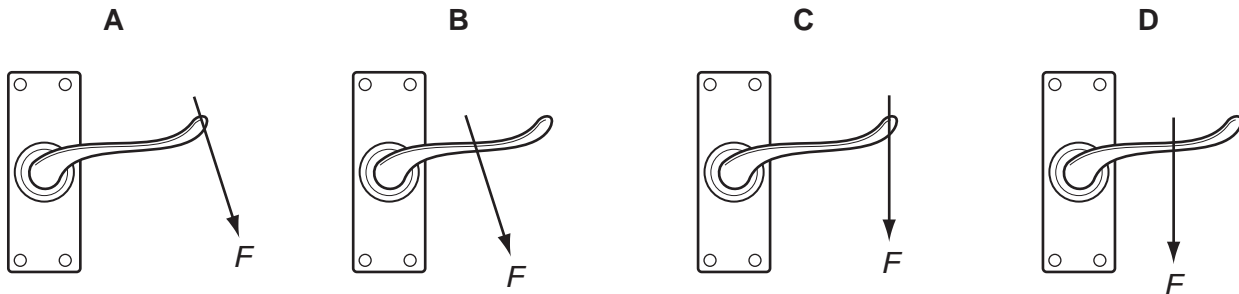
C $\frac{Fr}{2\pi}$

D zero

Space for working

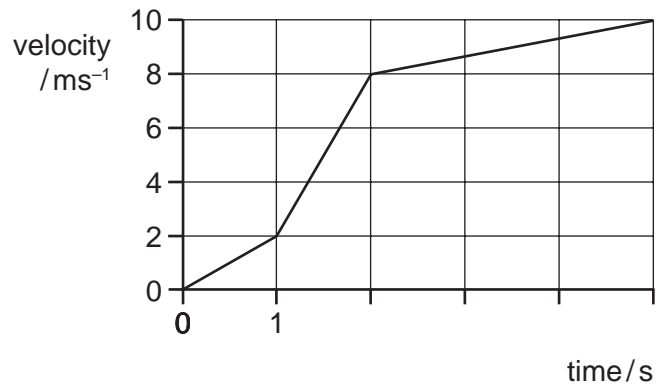
33 The diagrams show a force of magnitude F being applied to the same door handle.

Which diagram shows the greatest moment?



34 An athlete runs along a track.

A student draws a graph to represent how the velocity of the athlete varies with time for the first five seconds of his run.



What is the maximum acceleration and total distance run during these five seconds?

	maximum acceleration /m s ⁻²	distance run /m
A	2	33
B	2	50
C	6	33
D	6	50

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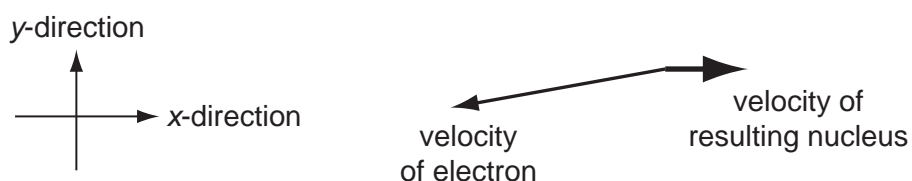
- 35 The Yangtze River Dam in China, like all dams, must be wider at its base due to the increased water pressure.

The depth of the water is 74 m. The density of water is 0.998 g cm^{-3} .

What is the pressure exerted on the base of the dam by the water?

- A** 0.72 kPa **B** 7.5 kPa **C** 74 kPa **D** 720 kPa

- 36 A stationary nucleus undergoes beta-decay. The diagram shows the velocities of the resulting nucleus and the emitted electron.



How does **this diagram** support the idea that a third, unseen particle is also emitted?

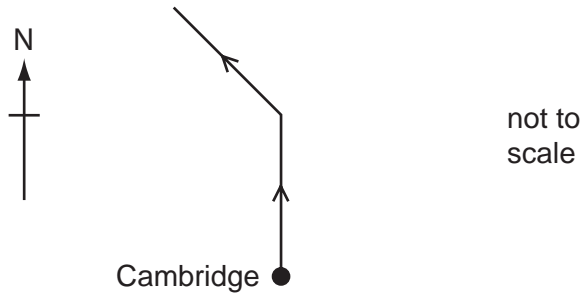
- A** If there were only two particles involved, their velocities should be equal and opposite.
B It is clear that linear momentum is not conserved in the x-direction.
C Something must carry away the extra energy.
D The original nucleus had no y-component of linear momentum.

Space for working

37 The air-traffic control centre at Cambridge looks after all aircraft within a 250 mile radius of Cambridge.

A small aircraft, flying due north at 200 miles per hour, passes over Cambridge at 12:00pm. It carries enough fuel for another 350 miles of flying.

At 12:30pm, air traffic control instructs the pilot to turn through 45° onto a north-westerly bearing. The aircraft continues at 200 miles per hour until 1:30pm.



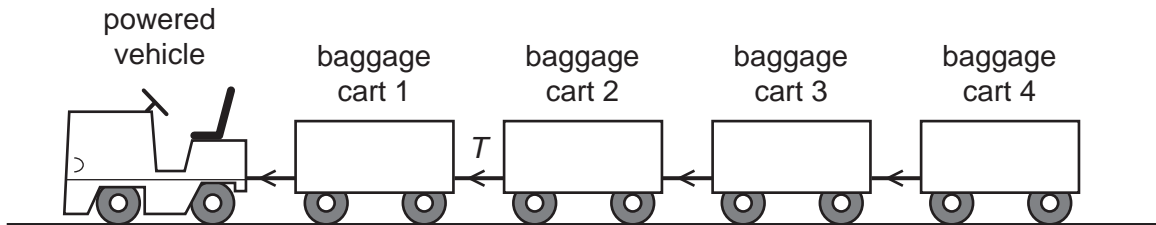
At 1:30pm the aircraft is still 80 miles from its destination.

What is the location of the aircraft and which action is required?

	location of aircraft	action required
A	outside Cambridge's air-traffic control space	carry on to destination
B	outside Cambridge's air-traffic control space	make an emergency landing before getting to destination
C	within Cambridge's air-traffic control space	carry on to destination
D	within Cambridge's air-traffic control space	make an emergency landing before getting to destination

Space for working

- 38 A transport system, used to move luggage from the airport terminal to the aircraft, consists of a powered vehicle connected to four baggage carts by a series of connecting bars.



The mass of the powered vehicle is 200 kg and each of the baggage carts has a mass of 400 kg.

The system starts with an acceleration of 2.0 m s^{-2} .

What is the tension T in the connecting bar between baggage carts 1 and 2? (Ignore any friction forces on the carts.)

- A** 800 N **B** 1200 N **C** 2400 N **D** 3600 N

Space for working

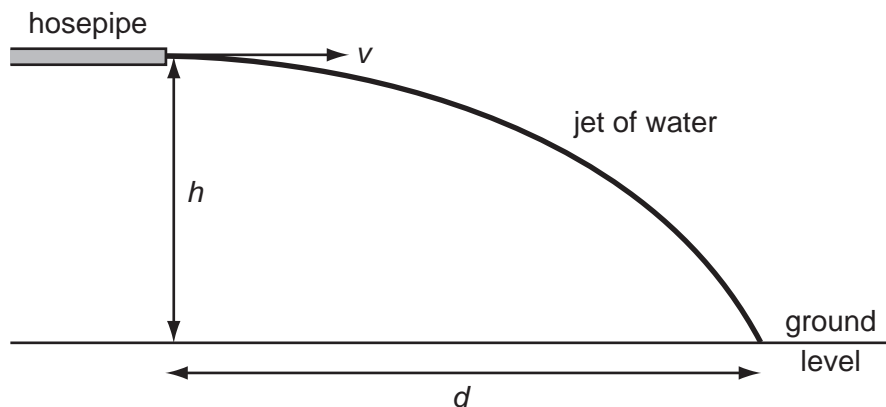
- 39 The flat vertical wall of a building has area 60 m^2 . It is hit perpendicularly by air moving at 8.0 m s^{-1} .

Assume that all of the momentum of the air is lost on hitting the wall.

What is the force exerted on the wall? (density of air = 1.3 kg m^{-3})

- A** 0.62 kN **B** 3.0 kN **C** 5.0 kN **D** 49 kN

40 A hosepipe is fixed as shown.



The jet of water emerges with a horizontal velocity v . The hosepipe is fixed at a height h above the ground. The water jet hits the floor at a horizontal distance d from the nozzle tip. The gravitational field strength is g .

What is the expression for distance d ? (Ignore air resistance.)

- A** $d = \frac{vg}{2h}$ **B** $d = \frac{2vh}{g}$ **C** $d = v\sqrt{\frac{g}{2h}}$ **D** $d = v\sqrt{\frac{2h}{g}}$

Space for working

41 Which quantity is a vector?

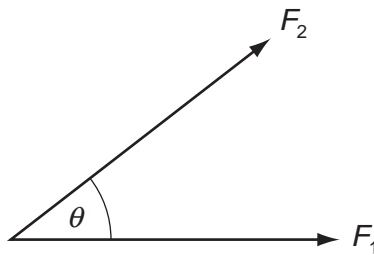
A kinetic energy

B speed

C weight

D work

42 Two forces F_1 and F_2 act with an angle θ between them.



Which combination could produce a resultant force of magnitude 1 N?

	F_1/N	F_2/N	θ
A	1	1	less than 90°
B	1	1	more than 90° but less than 180°
C	2	1	less than 90°
D	2	1	more than 90° but less than 180°

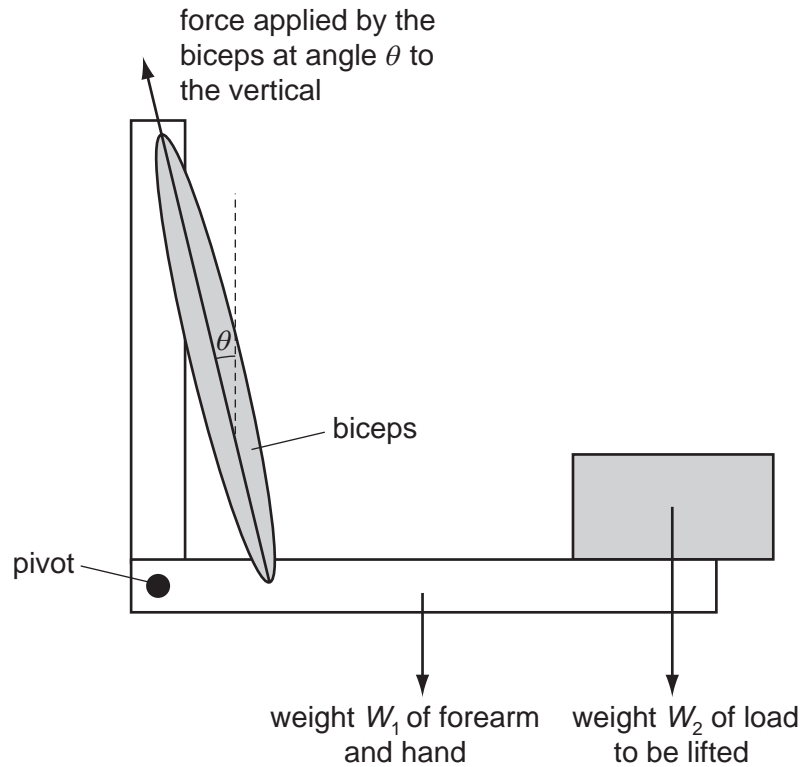
Space for working

- 43 A racing driver enters the home straight at 50 m s^{-1} . He then accelerates uniformly until he passes the finish line, 432 m away. At this time he is moving at 70 m s^{-1} .

Which statement is correct?

- A The acceleration is 20 m s^{-2} .
- B The time taken to reach the finish line is 2.0 s.
- C The time taken to reach the finish line is 7.2 s.
- D When the driver's speed is 60 m s^{-1} , he is 216 m from the finish line.

- 44 The diagram shows a model of an arm. A force applied by the biceps muscle can hold the arm in equilibrium while it supports a load.



Which statement is correct when the arm is in equilibrium in the position shown?

- A The force at the pivot is zero.
- B The force from the biceps is bigger when the load is moved nearer to the pivot.
- C The force from the biceps is equal to $W_1 + W_2$.
- D The resultant force on the biceps is zero.

Space for working

- 45 A man applies a horizontal force to a supermarket trolley and the trolley accelerates uniformly in the direction of the force.

Which statement is correct?

- A The force applied by the man on the trolley equals the force applied by the trolley on the man.
 - B The force applied by the man on the trolley is greater than the force applied by the trolley on the man.
 - C The forces acting on the trolley are in equilibrium.
 - D The total frictional force acting on the trolley equals the force applied by the man on the trolley.
- 46 A body of mass 8.0 kg moving at 5.0 m s^{-1} collides with a stationary body of mass 12 kg. They both move off with the same velocity.

Which statement is correct?

- A Kinetic energy is conserved and their common velocity is 2.0 m s^{-1} .
 - B Kinetic energy is conserved and their common velocity is 3.2 m s^{-1} .
 - C Momentum is conserved and their common velocity is 2.0 m s^{-1} .
 - D Momentum is conserved and their common velocity is 3.2 m s^{-1} .
- 47 A vehicle is used to explore under the sea. The force due to the water on its horizontal rectangular window, which measures 50.0 cm by 40.0 cm, is $8.24 \times 10^6 \text{ N}$.

At what depth is the window? (Average density of sea water is $1.03 \times 10^3 \text{ kg m}^{-3}$).

- A 40.8m B 163m C $4.08 \times 10^3 \text{ m}$ D $4.00 \times 10^4 \text{ m}$

Space for working