3. Dynamics

3.2 Non-uniform motion

Paper 1

Question Paper

1 A football is kicked so that it moves vertically upwards through the air.

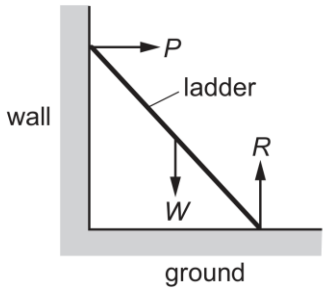
What is the variation in the air resistance and the resultant force acting on the ball as it moves vertically upwards?

	air resistance	resultant force
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

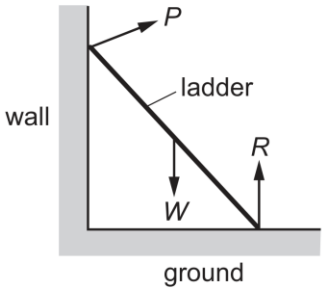
2 A ladder is positioned on icy (frictionless) ground and is leant against a rough wall. At the instant of release it begins to slide.

Which diagram shows the directions of the forces *P*, *W* and *R* acting on the ladder as it slides?

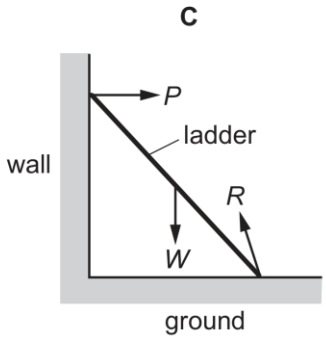
A



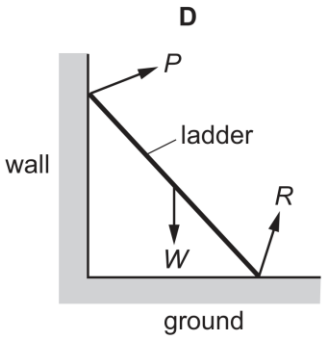
B



C



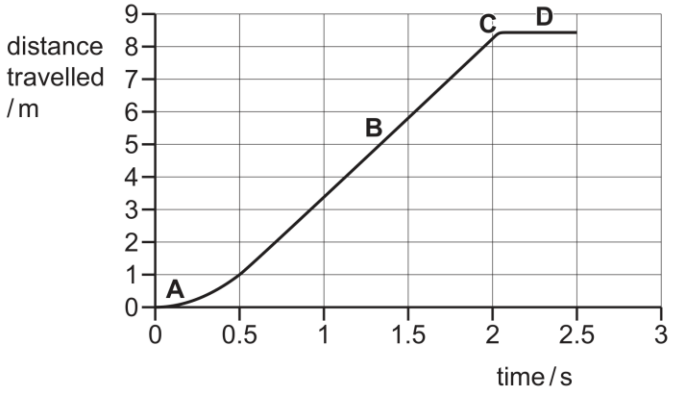
D



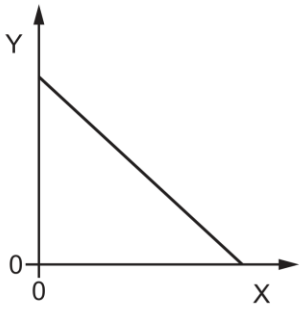
3 A toy parachute is dropped from a bridge and falls vertically through the air.

The graph shows the distance travelled by the parachute against time.

Which region of the graph shows when the parachute is at terminal velocity?



4 The graph shows how a quantity Y varies with a quantity X for an object falling vertically at its terminal velocity towards the surface of the Earth.

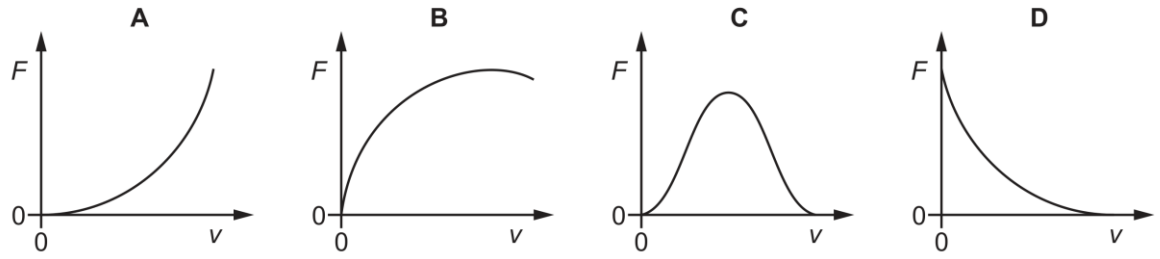


Which quantities could X and Y represent?

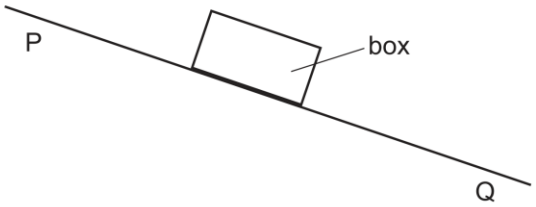
	X	Y
A	time	acceleration
B	time	height above surface
C	distance moved	kinetic energy
D	distance moved	velocity

5 A small ball is held at the surface of liquid oil in a container. The ball is released from rest and falls through the oil. The ball has velocity *v*. A viscous (drag) force *F* acts on the ball.

Which graph could show the variation with *v* of *F*?



6 A box in air slides with increasing speed down a rough slope from point P to point Q.



The slope surface exerts a constant frictional force on the box.

As the box moves from P to Q, there are changes to the magnitudes of its acceleration and the total resistive force acting on it.

Which row describes the changes?

	magnitude of acceleration	magnitude of total resistive force
A	increases	decreases
B	decreases	decreases
C	increases	increases
D	decreases	increases

7 In an experiment, a metal ball is dropped into a viscous liquid. The terminal velocity of the ball in the liquid is measured.

The experiment is repeated four times. For each repeat, a change is made to one of the following.

1 the density of the metal of the ball

2 the height from which the ball is dropped

3 the density of the liquid

4 the depth of the liquid

Which two changes separately affect the terminal velocity of the ball in the liquid?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

8 An object falls from a stationary helicopter and reaches terminal velocity.

What happens to the acceleration of the object between leaving the helicopter and reaching terminal velocity?

A It decreases to $9.81\,m\,s^{-2}$.

B It decreases to zero.

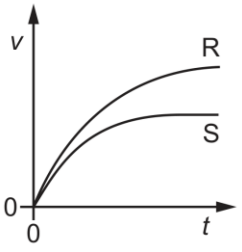
C It increases to $9.81\,m\,s^{-2}$.

D It remains constant at $9.81\,m\,s^{-2}$.

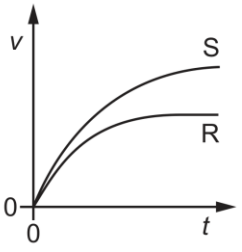
9 A stone S and a foam rubber ball R are identical spheres of equal volume. They are released from rest at time $t = 0$ and fall vertically through the air. Both reach terminal velocity.

Which graph best shows the variation with time t of the speed v of the stone and of the rubber ball?

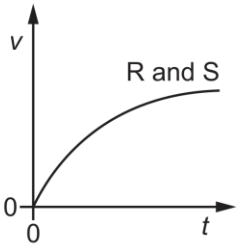
A



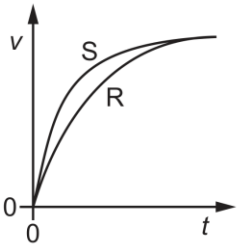
B



C



D



10 A snowflake and a raindrop are in still air. They both fall from rest at the same time and from the same height, far above the ground.

The snowflake and raindrop contain the same mass of water. Assume that there is no evaporation or melting. Also assume that, for a given speed, the drag force acting on the snowflake is greater than the drag force acting on the raindrop.

Which statement about the snowflake and raindrop is correct?

A The raindrop takes more time than the snowflake to reach terminal velocity.

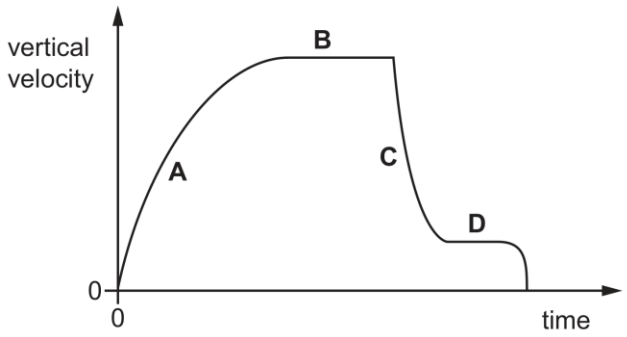
B The raindrop takes more time than the snowflake to reach the ground.

C They reach the same terminal velocity.

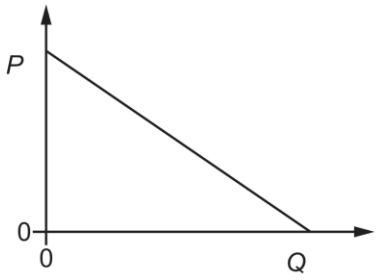
D They take the same amount of time to reach the ground.

11 A parachutist falls from rest from a balloon. The variation with time of the vertical velocity of the parachutist is shown.

In which region is the force due to air resistance much greater than the weight of the parachutist?



12 The graph shows how quantity *P* varies with quantity *Q* for a body falling vertically downwards in a uniform gravitational field with air resistance.

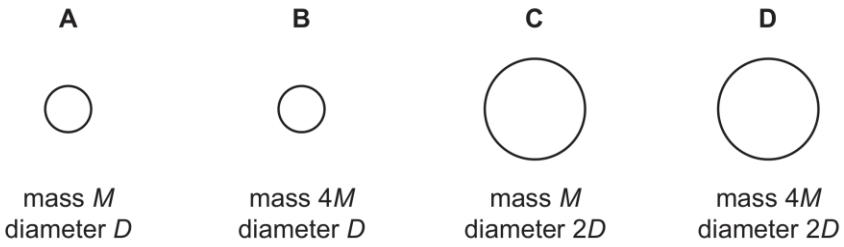


Which pair of quantities could be represented by *P* and *Q*?

	P	*Q*
A	acceleration	force of air resistance
B	acceleration	time
C	velocity	force of air resistance
D	velocity	time

13 Four balls are dropped at the same time from the top of a very tall tower. There is no wind blowing.

Which ball hits the ground first?



14 The resultant force *F* on a raindrop of mass *m* falling with velocity *v* is given by the equation

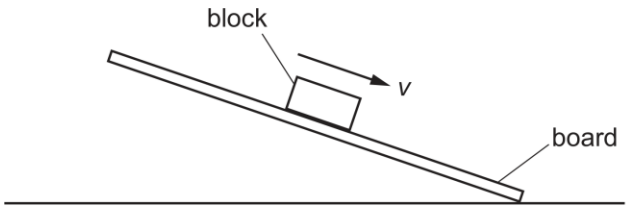
$$F = mg - kv^2$$

where *k* is a constant and *g* is the acceleration of free fall.

What is the velocity of the raindrop when it reaches a constant (terminal) velocity?

A $\sqrt{\frac{k}{mg}}$ **B** $\frac{k}{mg}$ **C** $\sqrt{\frac{mg}{k}}$ **D** $\frac{mg}{k}$

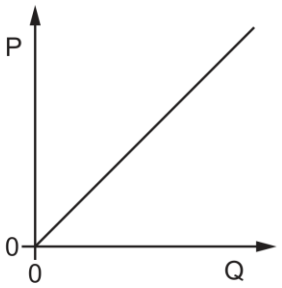
15 A wooden block rests on the rough surface of a board. One end of the board is then raised until the block slides down the board at constant velocity *v*.



What describes the forces acting on the block when it is sliding with constant velocity?

	frictional force on block	resultant force on block
A	down the board	down the board
B	down the board	zero
C	up the board	down the board
D	up the board	zero

16 The graph shows how quantity P varies with quantity Q for an object falling in air for a long time in a uniform gravitational field.

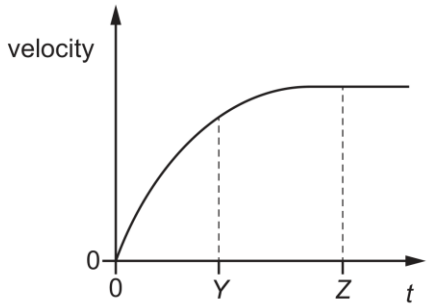


What could be the identities of P and Q?

	P	Q
A	force of air resistance	acceleration
B	kinetic energy	time
C	potential energy	height
D	work done against air resistance	speed

17 An object falls from a tall building.

The graph shows how the velocity of the object changes with time *t*.



The acceleration of free fall is *g*.

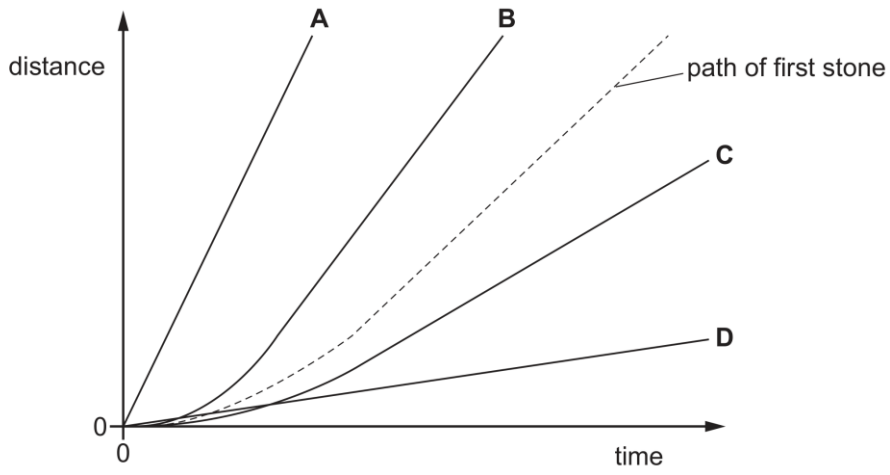
What describes the acceleration of the object at times $t = Y$ and $t = Z$?

	acceleration at $t = Y$	acceleration at $t = Z$
A	decreasing	*g*
B	decreasing	0
C	constant	*g*
D	constant	0

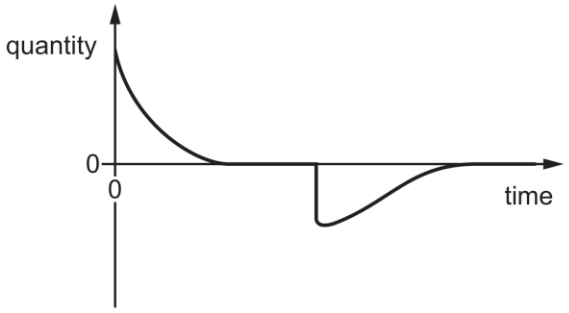
18 A stone is dropped from a tall building. Air resistance is significant. The variation of distance fallen with time is shown by the dashed line.

A second stone with the same dimensions but a smaller mass is dropped from the same building.

Which line represents the motion of the second stone?



19 The graph shows how a physical quantity varies with time.



Which event could best be represented by the graph?

A the acceleration of a firework rising to a maximum height and falling to the ground

B the acceleration of a skydiver leaving an aircraft, falling, opening a parachute and falling to the ground

C the speed of a javelin as it leaves an athlete's hand, falls and sinks into the ground

D the speed of a high jump athlete leaving the ground, jumping over a bar and descending to the ground

20 A skydiver falls from an aircraft that is moving horizontally.

The vertical component of the velocity of the skydiver is *v*.

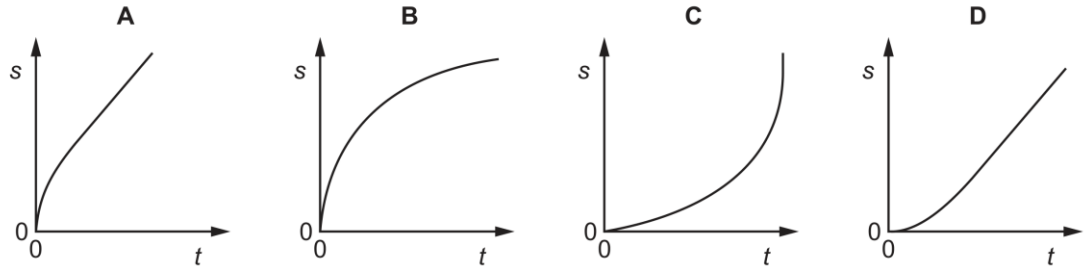
The vertical component of the acceleration of the skydiver is *a*.

Which row describes *v* and *a* during the first few seconds after the skydiver leaves the aircraft?

	v	*a*
A	constant	constant
B	constant	decreasing
C	increasing	constant
D	increasing	decreasing

21 A tennis ball is released from rest at time $t = 0$ and falls through air for a long time.

Which graph of its displacement s against time t best represents the motion of the ball?



22 A tennis ball is thrown horizontally in air from the top of a tall building.

The effect of air resistance is **not** negligible.

What happens to the horizontal and to the vertical components of the ball's velocity?

	horizontal component of velocity	vertical component of velocity
A	constant	constant
B	constant	increases at a constant rate
C	decreases to zero	increases at a constant rate
D	decreases to zero	increases to a maximum value