1)

(a) Define the *newton*.

....

.... **[1]**

(b) State why the equation '$F = ma$' cannot be applied to particles travelling at speeds very close to the speed of light.

....

.... **[1]**

(c) Fig. 3.1 shows the horizontal forces acting on a car of mass 900 kg when it is travelling at a particular velocity on a level-road.

Fig. 3.1

The total forward force between the tyres and the road is 200 N and the air resistance (drag) is 80 N.

(i) Calculate the acceleration of the car.

acceleration = ... $m s^{-2}$ **[2]**

(ii) Explain why we cannot use the equation $v = u + at$ to predict the velocity of the car at a later time even when the forward force is constant.

....

.... **[1]**

(d) Fig. 3.2 shows a person being lifted vertically upwards by a rope.

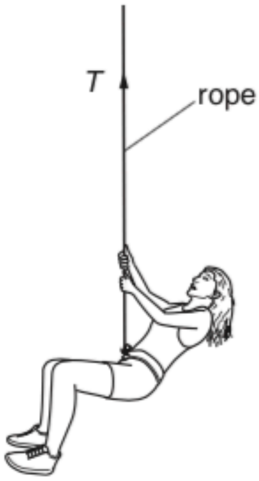


Fig. 3.2

The mass of the person is 72 kg. The upward vertical acceleration of the person is 1.4 m s^{-2}.
Calculate the tension T in the rope.

T = ... N **[3]**

[Total: 8]

2)

Use your knowledge of physics to state if each statement is correct or incorrect. You then need to explain the reason for your answer. An example has been done for you:

In a vacuum, a 2.0 kg object will fall faster towards the ground than an object of mass 1.0 kg.

This statement is **incorrect**.
Explanation: **All objects falling towards the Earth in a vacuum have the same acceleration**.

(a) The mass of a particle (e.g. electron) remains constant as its speed approaches the speed of light.

This statement is ....

Explanation: ....

....

.... **[2]**

(b) A ball is thrown vertically upwards. Air resistance has negligible effect on its motion. During the flight, the total energy of the ball remains constant.

This statement is ....

Explanation: ....

....

.... **[2]**

(c) An object falling through air has a terminal velocity of $30\,\text{m}\,\text{s}^{-1}$. At terminal velocity, the weight of the object is equal to the acceleration of free fall.

This statement is ....

Explanation: ....

....

.... **[2]**

(d) The technique of 'triangle of vectors' is used by a global positioning system (GPS) to locate the position of cars.

In your answer, you should use appropriate technical terms, spelled correctly.

This statement is ....

Explanation: ....

....

.... **[2]**

[Total: 8]

3)

Fig. 5.1 shows a person standing in a stationary lift.

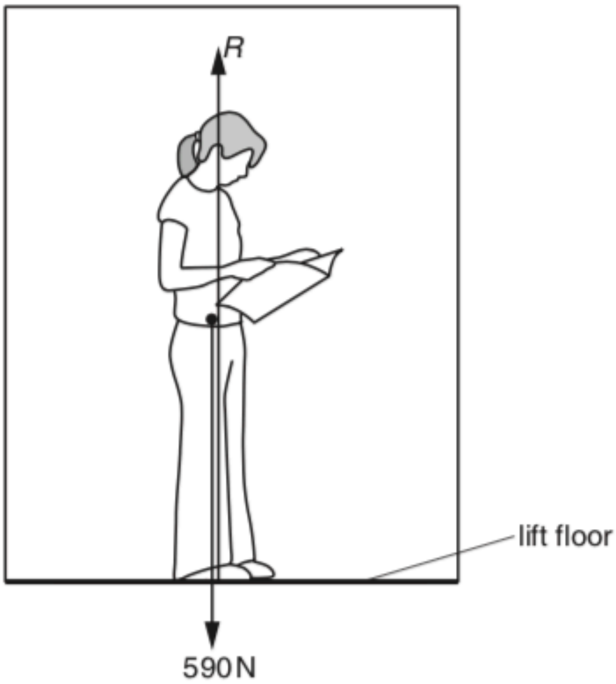


Fig. 5.1

There are only two forces acting on the person. The weight of the person is 590N. The vertical contact force acting on the person from the floor of the lift is *R*.

(a) Show that the mass of the person is 60kg.

[1]

(b) The lift starts from rest. It has a constant upward acceleration of $0.50\,m\,s^{-2}$. Calculate the magnitude of the contact force *R*.

R = ... N **[2]**

(c) After a short period of acceleration, the lift travels upwards at a constant velocity. Explain why the force R is equal to the weight of the person when the lift travels at a constant velocity.

....

....

.... **[1]**

(d) State and explain how the force R changes at the instant the lift starts to decelerate.

....

....

....

.... **[2]**

[Total: 6]

4)

(a) Fig. 5.1 shows a 20 N force acting at an angle of 38° to the horizontal.

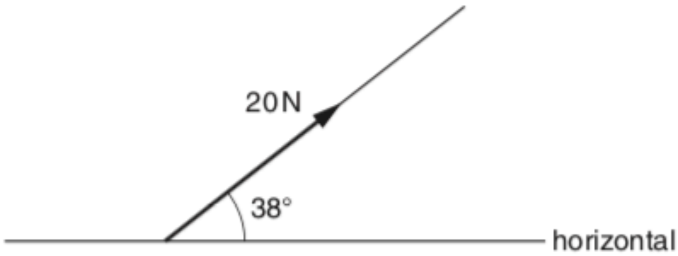


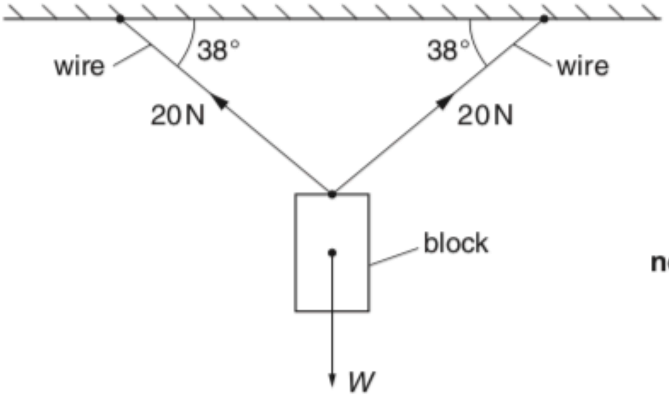
Fig. 5.1

Determine the horizontal and vertical components of this force.

horizontal component = ... N **[1]**

vertical component = ... N **[1]**

(b) Fig. 5.2 shows a metal block held in equilibrium by two wires.



not to scale

Fig. 5.2

The tension in each wire is 20 N.

(i) Show that the weight W of the metal block is about 25 N.

[2]

(ii) The metal block has a volume of $2.9 \times 10^{-4}\,m^3$. Calculate the density of the metal.

density = ... $kg\,m^{-3}$ **[3]**

[Total: 7]

5)

Fig. 2.1 shows two masses **A** and **B** tied to the ends of a length of string. The string passes over a pulley. The mass **A** is held at rest on the floor.

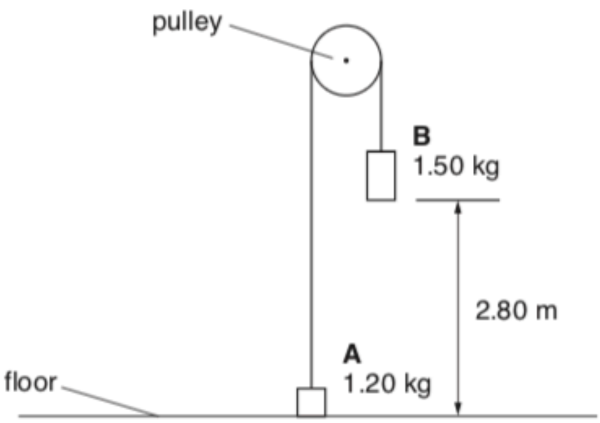


Fig. 2.1

The mass **A** is 1.20 kg and the mass **B** is 1.50 kg.

(a) Calculate the weight of mass **B**.

weight = ... N **[1]**

(b) Mass **B** is initially at rest at a height of 2.80 m above the floor. Mass **A** is then released. Mass **B** has a constant downward acceleration of $1.09\,m\,s^{-2}$. Assume that air resistance and the friction between the pulley and the string are negligible.

(i) In terms of forces, explain why the acceleration of the mass **B** is less than the acceleration of free fall *g*.

....

.... **[1]**

6)

A lift has a mass of 500 kg. It is designed to carry a maximum of 8 people of total mass 560 kg. The lift is supported by a steel cable of cross-sectional area $3.8 \times 10^{-4}\,m^2$. When the lift is at ground floor level the cable is at its maximum length of 140 m, as shown in Fig. 3.1. The mass per unit length of the cable is $3.0\,kg\,m^{-1}$.

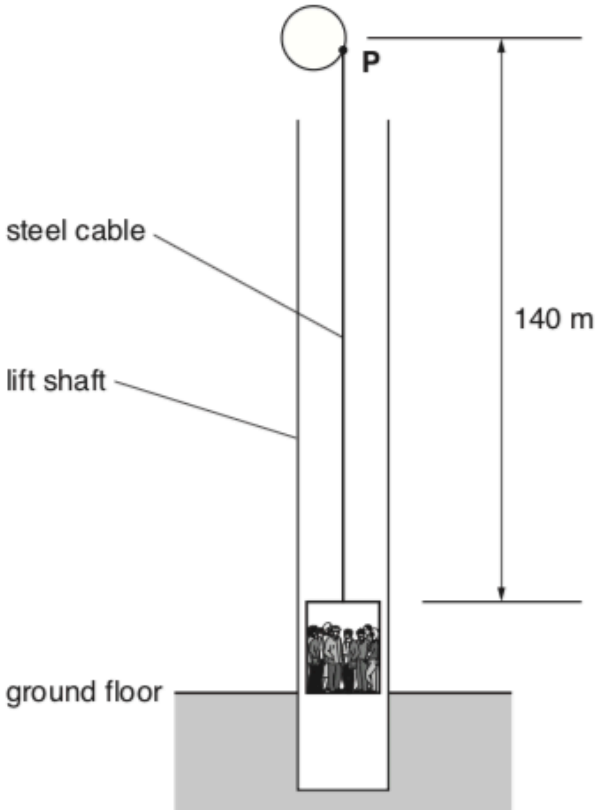


Fig. 3.1

(a) Show that the mass of the 140 m long steel cable is 420 kg.

[1]

(b) **(i)** The lift with its 8 passengers is stationary at the ground floor level. The initial upward acceleration of the lift and the cable is $1.8\,m\,s^{-2}$. Show that the **maximum** tension in the cable at point **P** is $1.7 \times 10^4\,N$.

[4]

(ii) Calculate the maximum stress in the cable.

stress = ... Pa **[2]**

[Total: 7]

7)

Fig. 4.2 shows a ship **S** being pulled by two tug-boats.

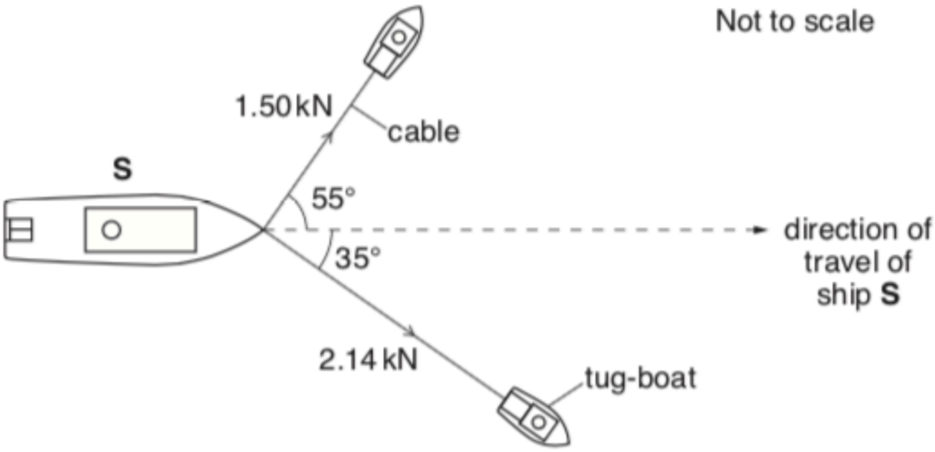


Fig. 4.2

The ship is travelling at a constant velocity. The tensions in the cables and the angles made by these cables to the direction in which the ship travels are shown in Fig. 4.2.

(i) Draw a vector triangle and determine the resultant force provided by the two cables.

resultant force = ... kN **[3]**

(ii) State the value of the drag force acting on the ship **S**. Explain your answer.

....

....

.... **[2]**

8)

(a) Define *acceleration*.

....

.... **[1]**

(b) State the **two** factors that affect the acceleration of an object.

....

.... **[1]**

(c) Fig. 4.1 shows the variation of velocity v with time t for a small rocket.

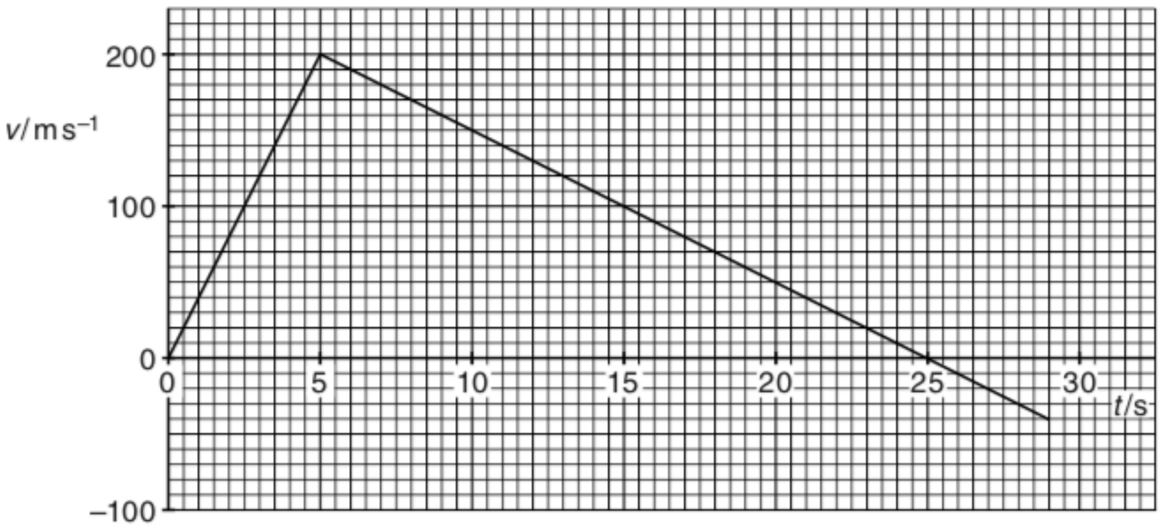


Fig. 4.1

The rocket is initially at rest and is fired vertically upwards from the ground. All the rocket fuel is burnt after a time of 5.0 s when the rocket has a vertical velocity of 200 m s^{-1}. Assume that air resistance has a negligible effect on the motion of the rocket.

(i) Without doing any calculations, describe the motion of the rocket

1 from $t = 0$ to $t = 5.0\,\text{s}$

....

....

2 from $t = 5.0\,\text{s}$ to $t = 25\,\text{s}$.

....

....

.... **[3]**

(ii) Calculate the maximum height reached by the rocket.

height = ... m **[3]**

(iii) Explain why the rocket has a speed greater than $200\,\text{m}\,\text{s}^{-1}$ as it hits the ground.

....

....

....

.... **[1]**

[Total: 9]

9)

(a) Define the *newton*.

....

.... **[1]**

(b) Fig. 3.1 shows a spaceship on the surface of the Earth.

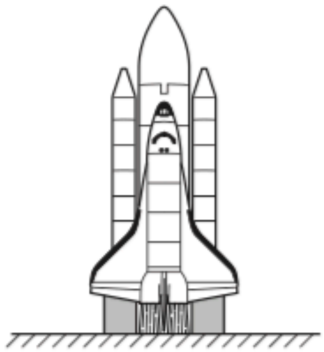


Fig. 3.1

The mass of the spaceship is 1.9×10^{6} kg. During lift off, the spaceship rockets produce a vertical upward force of 3.1×10^{7} N.

(i) Calculate the weight of the spaceship.

weight = ... N **[1]**

(ii) Calculate the initial vertical acceleration as the spaceship lifts off.

acceleration = ... $m\,s^{-2}$ **[2]**

(iii) The vertical upward force on the spaceship stays constant. Explain why the acceleration of the spaceship increases after lift off.

....

....

....

.... **[1]**

[Total: 5]

10)

(a) Define a *vector* quantity and give one example.

....

.... **[2]**

(b) Fig. 3.1 shows a force *F* at an angle of 30° to the horizontal direction.

Fig. 3.1

(i) The **horizontal component** of the force *F* is 7.0 N. Calculate the magnitude of the force *F*.

F = ... N **[2]**

(ii) The force *F* moves an object in the horizontal direction. In a time of 4.2 s, the object moves a horizontal distance of 5.0 m. Calculate

1 the work done by the force

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

2 the rate of work done by the force.

rate of work done = ... W **[1]**

(c) Fig. 3.2 shows the forces acting on a stage light of weight 120N held stationary by two separate cables.

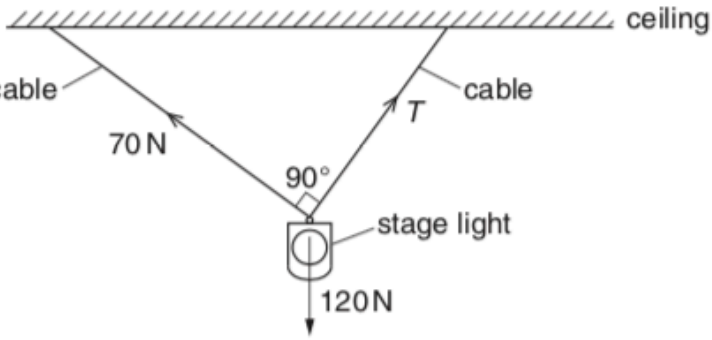


Fig. 3.2

The angle between the two cables is 90°. One cable has tension 70N and the other has tension *T*.

(i) State the magnitude and the direction of the **resultant** of the tensions in the two cables.

magnitude ....

direction .... **[2]**

(ii) Sketch a labelled vector triangle for the forces acting on the stage light. Hence, determine the magnitude of the tension *T*.

T = ... N **[4]**

[Total: 13]

11)

(a) Define *velocity*.

....

.... **[1]**

(b) Define *work done* by a force.

....

.... **[2]**

(c) Fig. 3.1 shows a rider on a sledge sliding down an icy slope.

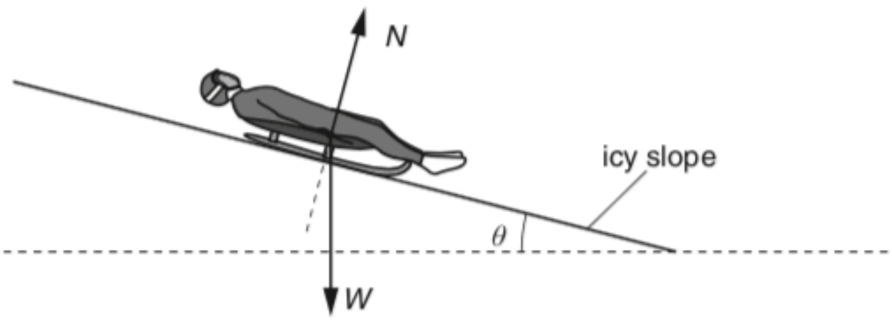


Fig. 3.1

The frictional forces acting on the sledge and the rider are negligible. The normal contact force N and the total weight W of the sledge and rider are shown.

(i) Explain why the force N does no work on the sledge as it slides down the slope.

....

.... **[1]**

(ii) State and explain the force that causes the sledge and rider to accelerate down the slope.

....

.... **[1]**

12)

Fig. 5.1 shows the vertical forces acting on a helium-filled weather balloon just before lift off.

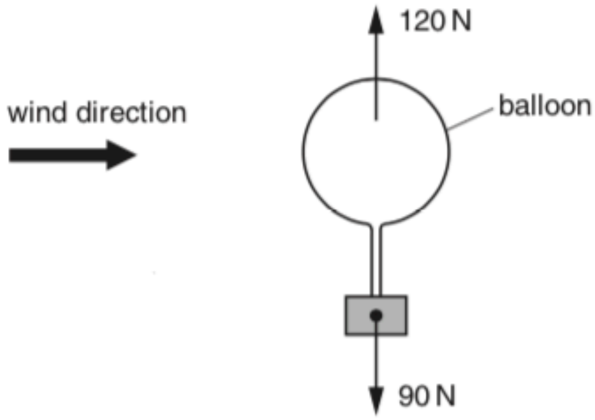


Fig. 5.1

The balloon experiences an upward vertical force (upthrust) equal to 120 N. The weight of the balloon and its contents is 90 N. The magnitude of the horizontal force provided by the wind is 18 N.

(a) Determine the magnitude of the resultant force acting on the balloon and the angle this resultant force makes with the horizontal.

net force = ... N

angle = ... °

[4]

(b) As the balloon rises through the air, it experiences a drag force. State two factors that affect the magnitude of the drag force on this balloon.

1. ....

2. .... **[2]**

[Total: 6]

13)

In February 1999 NASA launched its Stardust spacecraft on a mission to collect dust particles from the comet Tempel 1. After a journey of 5.0×10^{12} m that took 6.9 years, Stardust returned to Earth with samples of the dust particles embedded in a special low-density gel. When a dust particle hits the gel, it buries itself in the gel creating a cone-shaped track as shown in Fig. 6.1. The length of the track is typically 200 times the diameter of the dust particle.

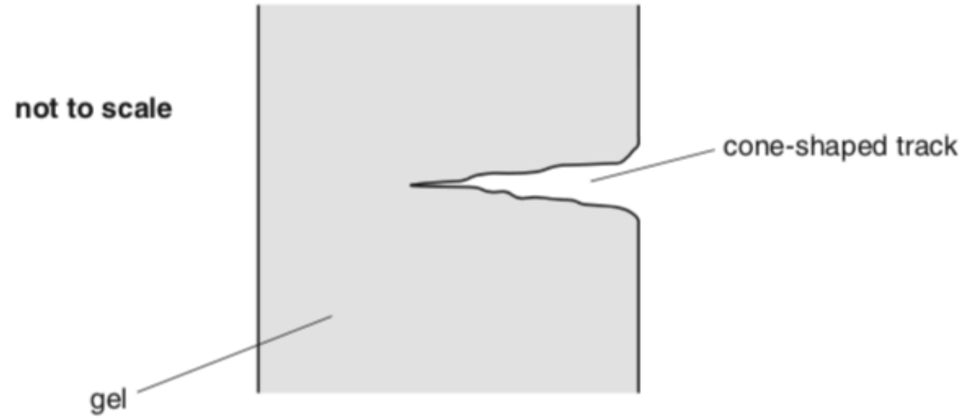


Fig. 6.1

(a) Calculate the average speed in m s^{-1} of Stardust during its voyage.

speed = ... ms^{-1} **[2]**

(b) Calculate the average stopping force produced by the gel for a dust particle of diameter 0.70 mm and mass 4.0×10^{-6} kg travelling at a velocity of 6.1×10^{3} ms^{-1} relative to Stardust.

force = ...N **[3]**

[Total: 5]

14)

(a) Explain why force is a *vector* quantity.

In your answer, you should use appropriate technical terms, spelled correctly.

....

.... **[1]**

(b) Fig. 2.1 shows the forces acting on a water drop on the windscreen of a stationary car.

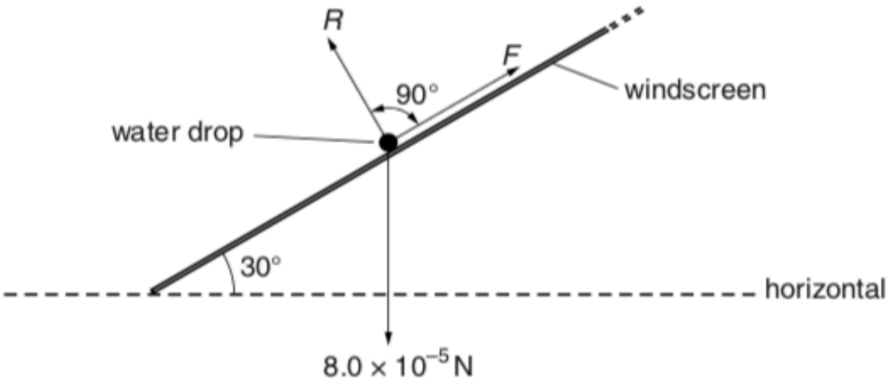


Fig. 2.1

The windscreen makes an angle of 30° to the horizontal. The weight of the water drop is 8.0×10^{-5} N. The normal contact force on the water drop is *R*. There is also a force *F* acting on the water drop as shown. The water drop is **stationary**.

(i) Use Fig. 2.1 to determine the component of the weight of the water drop

1 perpendicular to the windscreen

component = ... N

2 parallel to the windscreen.

component = ... N
[2]

(ii) Determine the magnitude of *F*. Explain your answer.

....

....

....

.... **[2]**

[Total: 5]

15)

(a) Aristotle and Galileo had different ideas about the way in which objects fall to the ground. Compare these ideas.

....

....

....

....

....

.... **[2]**

(b) Fig. 2.1 shows the graph of velocity against time for a parachutist falling vertically through the air. The initial vertical velocity is zero.

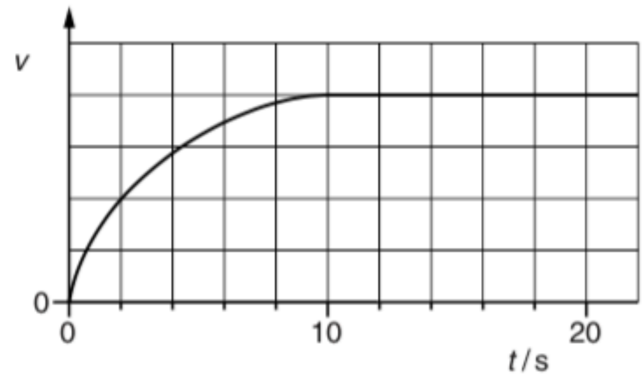


Fig. 2.1

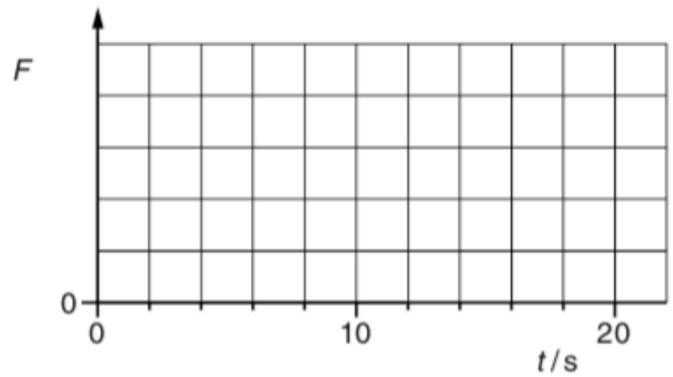


Fig. 2.2

(i) State **two** factors that affect the magnitude of the drag force on the parachutist.

....

.... **[1]**

(ii) State and explain the magnitude of the acceleration of the parachutist at the start of the fall.

....

....

....

.... **[2]**

(iii) On Fig. 2.2 sketch a graph to show the variation of the size of the **resultant** force F acting on the parachutist with time t. **[2]**

(iv) The total mass of the parachutist is 80 kg. Calculate the drag force acting on the parachutist at an acceleration of $3.0\,\mathrm{m\,s^{-2}}$.

drag force = ... N **[3]**