FORCES AND NEWTON'S LAWS MECHANICS PAST PAPER QUESTIONS OCR ALEVEL YEAR1

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.

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..... **[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.

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..... **[1]**

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

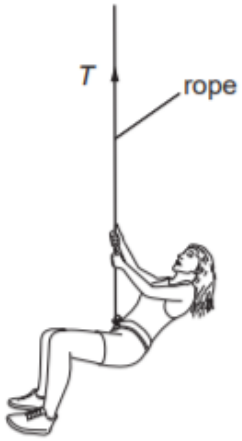


Fig. 3.2

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.

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

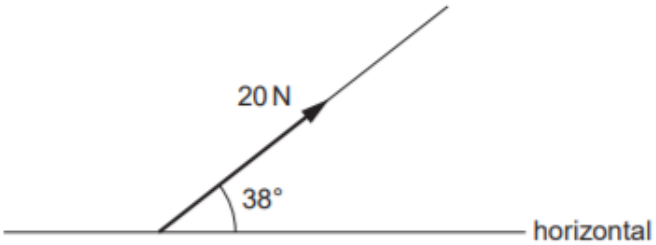


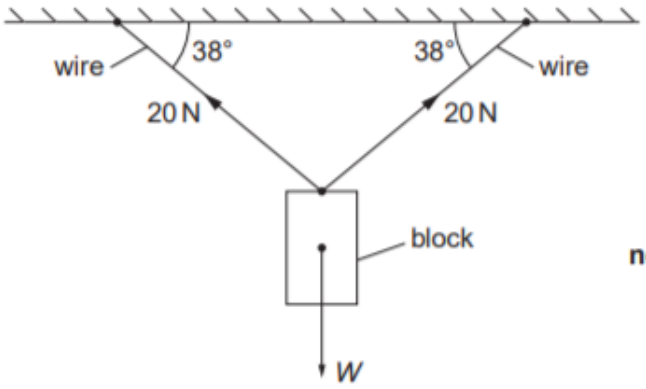
Fig. 5.1

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.

(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]

3.

(a) An electron in a particle accelerator experiences a constant force. According to one student, the acceleration of the electron should remain constant because the ratio of force to mass does not change. In reality, experiments show that the acceleration of the electron decreases as its velocity increases. Describe what can be deduced from such experiments about the nature of accelerated electrons.

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

(b) Fig. 4.1 shows the velocity vector for a particle moving at an angle of 31° to the horizontal.

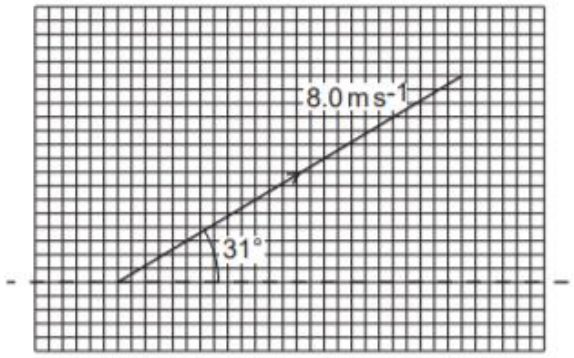

Fig. 4.1

(i) On Fig. 4.1, show the horizontal (*x*-direction) and vertical (*y*-direction) components of the velocity. **[2]**

(ii) Calculate the horizontal (*x*-direction) component of the velocity.

velocity = ... $m s^{-1}$ **[1]**

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

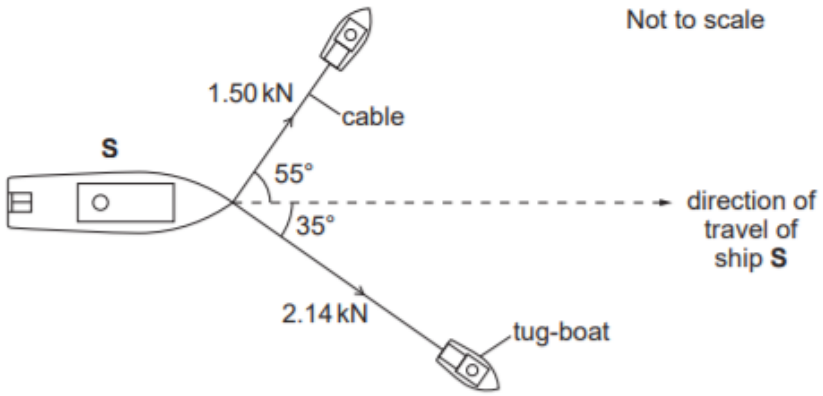

Fig. 4.2

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.

.....

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

[Total: 10]

4.

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

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..... **[1]**

(b) Fig. 3.1 shows a car travelling up a slope at a constant speed.

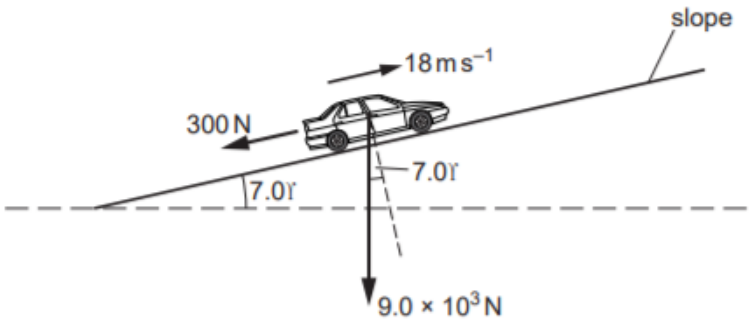

Fig. 3.1

The angle between the slope and the horizontal is 7.0°. The weight of the car is 9.0×10^3 N. The car travels up the slope at a constant speed of 18 m s^{-1}. A resistive force of 300 N acts on the car down the slope.

(i) What is the net force acting on the car? Explain your answer.

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

(ii) Calculate the component of the weight of the car acting down the slope.

component of weight = ... N **[2]**

(iii) Calculate the work done per second against the resistive force.

work done per second = ... Js^{-1} **[1]**

(iv) Calculate the power developed by the car as it travels up the slope.

power = ... W **[3]**

[Total: 9]

4.

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: .....

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..... **[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: .....

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

(c) An object falling through air has a terminal velocity of $30\,m\,s^{-1}$. 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: .....

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6.

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

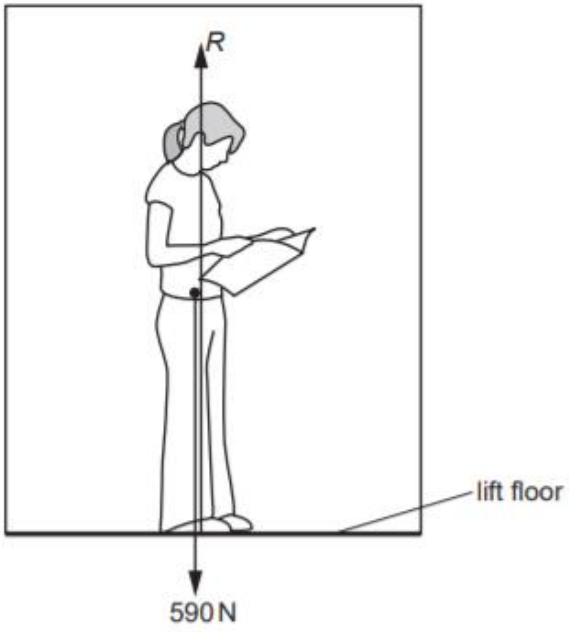

Fig. 5.1

There are only two forces acting on the person. The weight of the person is 590 N. 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 60 kg.

[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.

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..... **[1]**

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

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

[Total: 6]

7.

A car of mass 1200 kg is travelling at 18 m s^{-1} along a horizontal road. A constant braking force of 3600 N brings it to rest.

(a) Calculate the magnitude of the deceleration of the car.

deceleration = ... m s^{-2} **[1]**

(b) Calculate the distance travelled by the car during the deceleration.

distance = ... m **[3]**

(c) The same car travels **down** a slope at the same speed of 18 m s^{-1}, see Fig. 3.1.

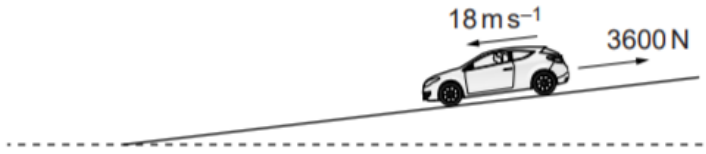

Fig. 3.1

The car is brought to rest by applying the brakes. The same resistive force of 3600 N acts on the car. Explain whether the distance travelled by the car before it stops is greater than, smaller than or the same as your answer to **(b)**.

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..... **[3]**

(d) Many cars are fitted with Global Positioning System (GPS) devices.

Describe how geostationary satellites are used to track the location of cars on the Earth's surface.

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

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..... **[4]**

[Total: 11]

8.

(a) State how the magnitude of the drag force on an object is affected by its speed.

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..... **[1]**

(b) Describe the experiments Galileo carried out which overturned Aristotle's ideas of motion.

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..... **[3]**

(c) A skydiver is falling towards the ground at a terminal velocity of $50\,m\,s^{-1}$.

(i) State the **two** main forces acting on the skydiver and how they are related at terminal velocity.

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..... **[1]**

(ii) The skydiver opens her parachute. After some time, the skydiver reaches a lower terminal velocity of $4.0\,m\,s^{-1}$. Describe and explain how the magnitude of the deceleration of the skydiver changes as her velocity reduces from $50\,m\,s^{-1}$ to $4.0\,m\,s^{-1}$.

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..... **[4]**

[Total: 9]

9.

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

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..... **[1]**

(b) Fig. 6.1 shows a water slide.

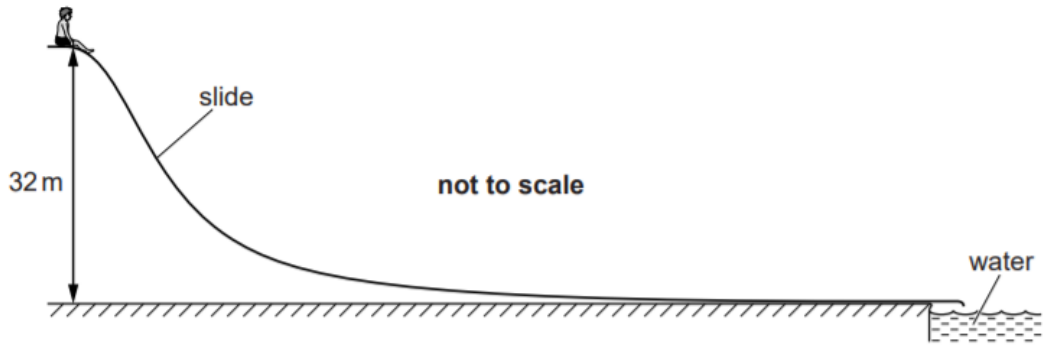

Fig. 6.1

The top of the slide is 32 m above the bottom of the slide. The total distance along the slide is 120 m. A person of weight 700 N, initially at rest at the top, slides down. His speed at the end of the slide is 15 m s^{-1}.

(i) Calculate his kinetic energy at the end of the slide.

kinetic energy = ... J **[2]**

(ii) Calculate the average resistive force acting on him as he travels down to the end of the slide.

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

[Total: 6]