Mixed Exercise 3

1.

(a) A student holds a golf ball and a table tennis ball out of an upper window of a tall building. The balls are released at the same time. Both balls have the same size. The golf ball has a **greater mass** than the tennis ball. One of the balls reaches a greater terminal velocity.

(i) State and explain the acceleration of the golf ball immediately after it is released.

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…… **[2]**

(ii) By referring to the forces acting on the golf ball, explain what is meant by *terminal velocity*.

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…… **[1]**

(iii) Explain which of the two balls reaches the greater terminal velocity.

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…… **[3]**

(b) Fig. 5.1 shows a graph of drag D against speed v for a lorry.

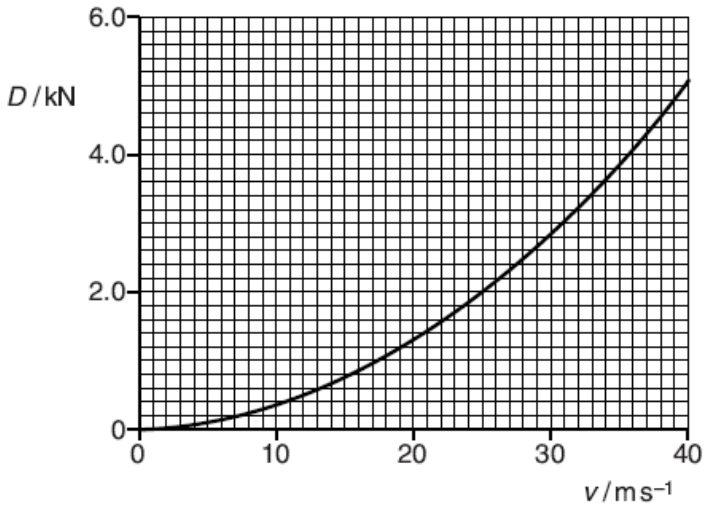

Fig. 5.1

The lorry has mass 8000 kg. Its engine provides a **constant** forward force of 3200 N.

(i) Calculate the instantaneous acceleration of the lorry when travelling on a level road at a speed of 25 $m s^{-1}$.

acceleration = ... $m s^{-2}$ **[3]**

(ii) Explain why this lorry cannot travel at a speed of 40 $m s^{-1}$ on a level road.

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

(c) The lorry driver wears a seat belt. Describe and explain how a seat belt reduces the force on a driver during the impact in an accident.

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

2.

(a) A student writes four incorrect statements shown in the table below. The error in each statement is circled. Write the correct answer for the circled unit or number; one has already been done for you.

Incorrect statement	Correct unit or number
The weight of a person is about 700 **kg**.	N
The atmosphere exerts a pressure of about 1.0×10^5 **N m^2**.	
A force of 1 N may be written as 1 kg **m^{-1} s^{-1}**.	
1 GW is **10** times bigger than 1 MW.	

[2]

(b) Fig. 1.1 shows the apparatus used to determine the density of glass.

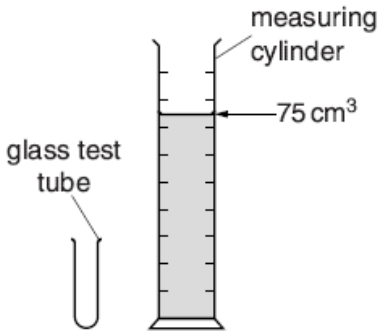

Fig. 1.1

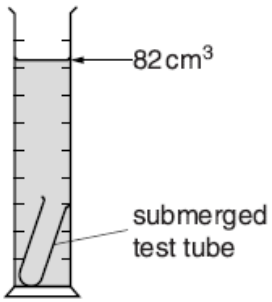

Fig. 1.2

The glass test tube has mass 1.6×10^{-2} kg. The measuring cylinder is partly filled with water. The test tube is gently pushed into the water until it is fully submerged as shown in Fig. 1.2. The level of the water inside the measuring cylinder increases from 75 cm^3 to 82 cm^3.

Calculate the density of the test tube glass in kg m^{-3}.

density = ... kg m^{-3} **[2]**

3.

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

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

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

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

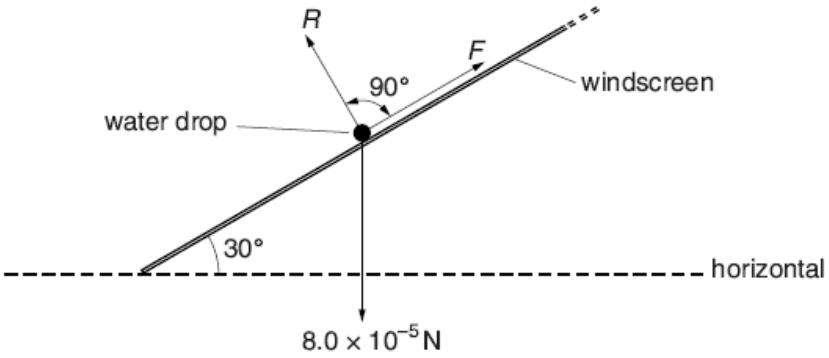

Fig. 2.1

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.

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

4.

Fig. 4.1 shows a metal ball held stationary above a tube containing oil.

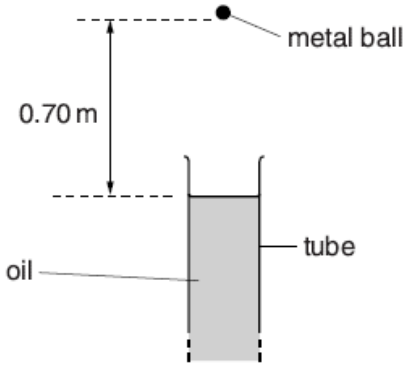

Fig. 4.1

(a) The ball is 0.70 m above the surface of the oil in the tube. Calculate the time taken for the ball to reach the surface of the oil when it is dropped from this height. Assume air resistance has negligible effect on the motion of the ball.

time = ... s **[3]**

(b) Fig. 4.2 shows the graph of velocity v against time t for the ball as it travels through the oil. The ball enters the oil at time $t = 0$.

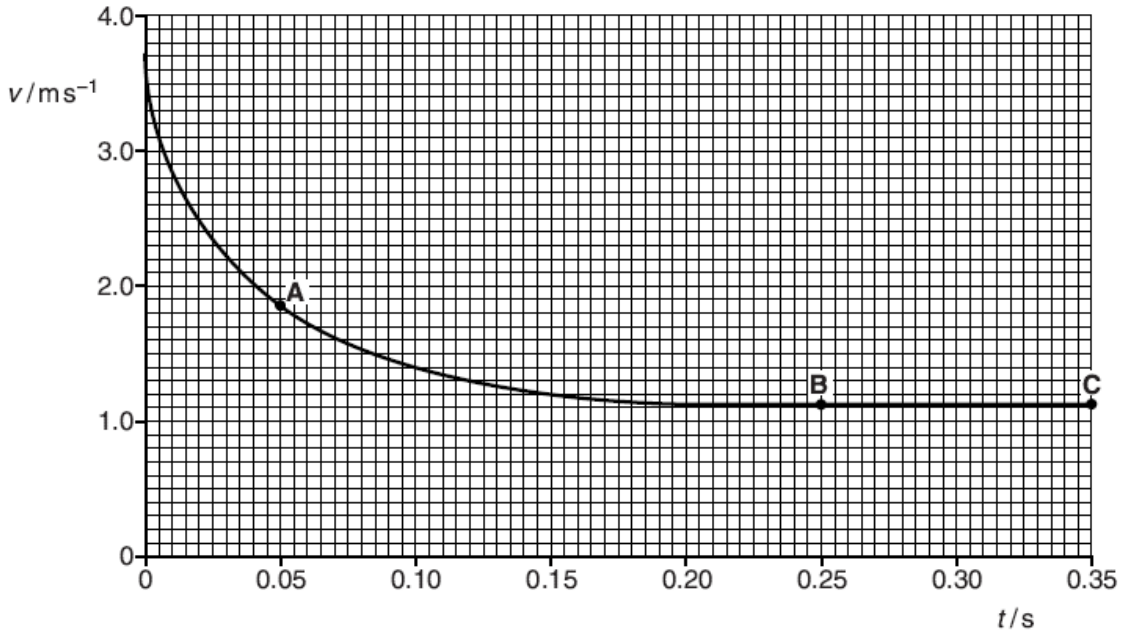

Fig. 4.2

(i) Complete the sentence below.

The gradient of the graph is equal to the ..... of the ball and

the area under the graph is equal to the ..... . **[1]**

(ii) Use Fig. 4.2 to determine the magnitude of the deceleration of the ball at time $t = 0.05\,s$ (point **A**). Show your working.

deceleration = ... $m\,s^{-2}$ **[3]**

(iii) In terms of the **forces** acting on the ball, describe and explain its motion when

1 time $t = 0.05\,s$ (point **A**)

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2 time $t = 0.25\,s$ (point **B**).

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[4]

(iv) Describe the energy transfers taking place between $t = 0.25\,s$ and $t = 0.35\,s$ (point **B** to **C**).

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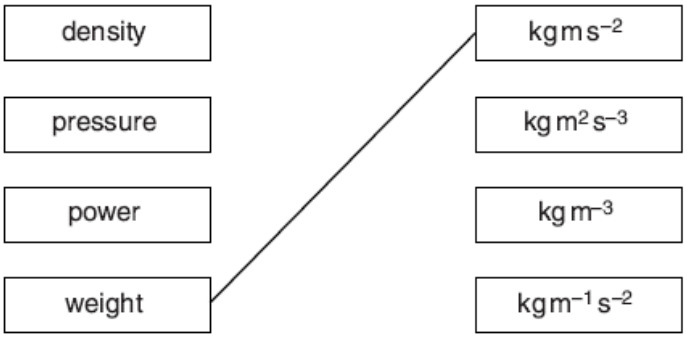
..... **[1]**

5.

Draw a line from each quantity on the left-hand side to the correct unit on the right-hand side. One quantity (weight) has already been matched to its unit.



[2]

6.

(a) Speed is a scalar quantity and velocity is a vector quantity. State one difference and one similarity between speed and velocity.

difference: .....

.....

similarity: .....

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

(b) Fig. 2.1 shows a toy locomotive on a circular track.

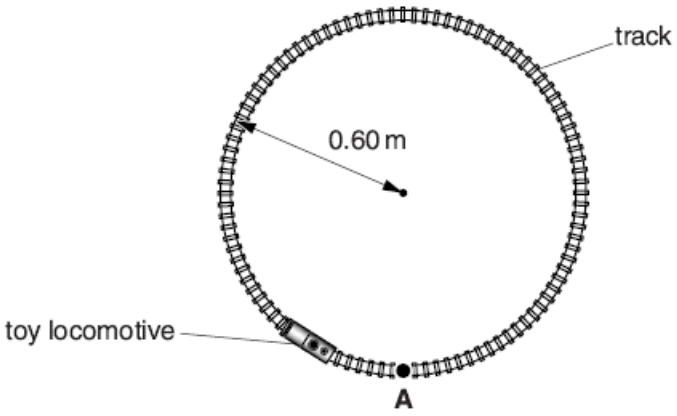


Fig. 2.1

The locomotive travels at constant speed round the track in a clockwise direction. It takes 12 s to travel completely round the track. At time $t = 0$, the locomotive is at point **A**.

(i) Calculate the speed of the locomotive.

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

(ii) Calculate the magnitude of the displacement s of the locomotive from point **A** after it has travelled one quarter of the way round the track.

s = ... m **[2]**

(iii) Explain why the average velocity of the locomotive is zero after a time of 12 s.

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

(iv) Explain why the velocity of the locomotive changes even though its speed is constant.

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

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.

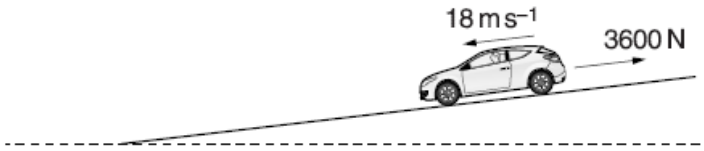

Fig. 3.1

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]**

8.

(a) Define *acceleration*.

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

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

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

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

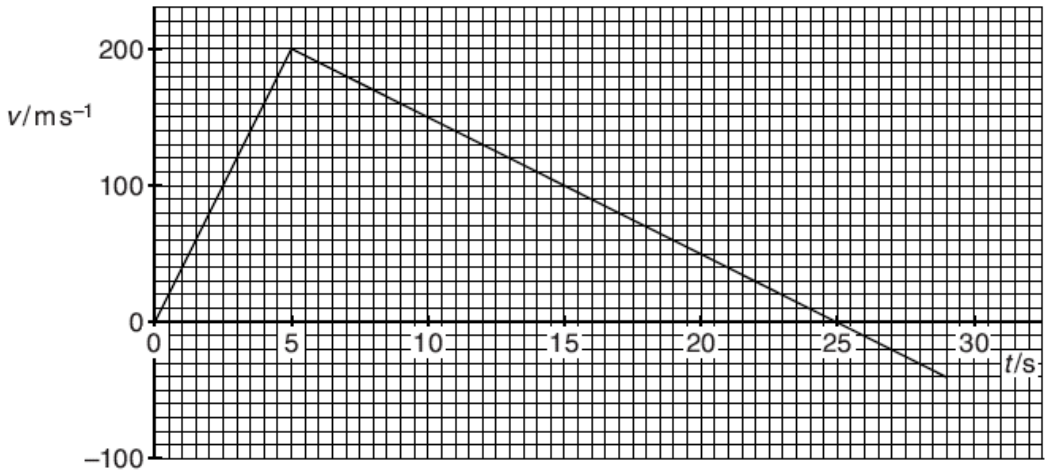

Fig. 4.1

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 $t = 5.0$ s

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2 from $t = 5.0$ s to $t = 25$ s.

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

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

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

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

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