Newton's Laws of Motion

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Dynamics
Sub Topic	Newton's Laws of Motion
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: **72 minutes**

Score: **/60**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** State Newton's first law of motion.

.....

..... [1]

(b) A box slides down a slope, as shown in Fig. 3.1.

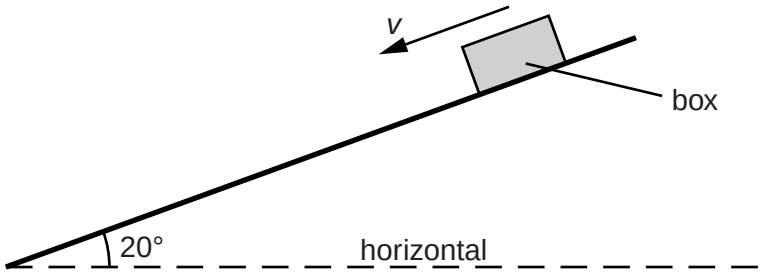

Fig. 3.1

The angle of the slope to the horizontal is 20°. The box has a mass of 65 kg. The total resistive force *R* acting on the box is constant as it slides down the slope.

(i) State the names and directions of the other two forces acting on the box.

1. .....

2. .....
[2]

(ii) The variation with time *t* of the velocity *v* of the box as it moves down the slope is shown in Fig. 3.2.

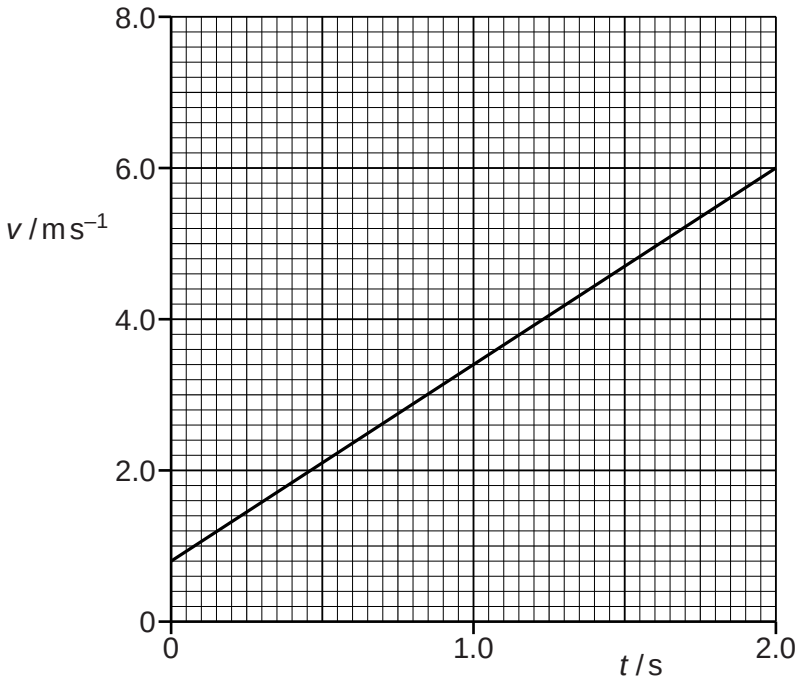

Fig. 3.2

1. Use data from Fig. 3.2 to show that the acceleration of the box is 2.6 m s^{-2}.

[2]

2. Calculate the resultant force on the box.

resultant force = ... N [1]

3. Determine the resistive force *R* on the box.

R = ... N [3]

2 **(a)** **(i)** Define *acceleration*.

.....

..... [1]

(ii) State Newton's first law of motion.

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..... [1]

(b) The variation with time *t* of vertical speed *v* of a parachutist falling from an aircraft is shown in Fig. 1.1.

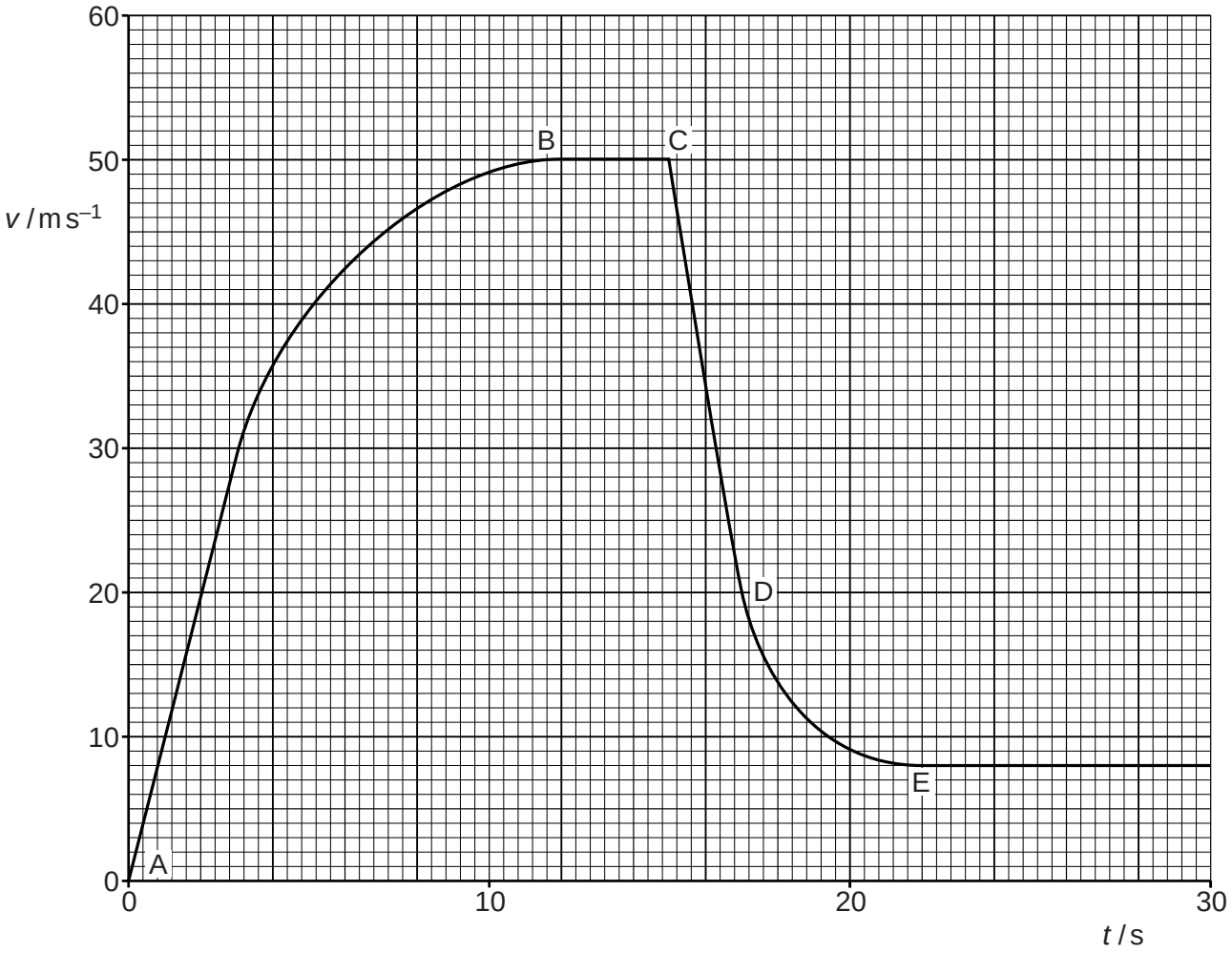

Fig. 1.1

(i) Calculate the distance travelled by the parachutist in the first 3.0 s of the motion.

distance = ... m [2]

(ii) Explain the variation of the resultant force acting on the parachutist from t = 0 (point A) to t = 15 s (point C).

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..... [3]

(iii) Describe the changes to the frictional force on the parachutist

1. at t = 15 s (point C),

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..... [1]

2. between t = 15 s (point C) and t = 22 s (point E).

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.....

..... [1]

(iv) The mass of the parachutist is 95 kg.

Calculate, for the parachutist between t = 15 s (point C) and t = 17 s (point D),

1. the average acceleration,

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

2. the average frictional force.

frictional force = ... N [3]

3 **(a)** State Newton's second law.

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..... [1]

(b) A ball of mass 65 g hits a wall with a velocity of 5.2 m s^{-1} perpendicular to the wall. The ball rebounds perpendicularly from the wall with a speed of 3.7 m s^{-1}. The contact time of the ball with the wall is 7.5 ms.

Calculate, for the ball hitting the wall,

(i) the change in momentum,

change in momentum = ... N s [2]

(ii) the magnitude of the average force.

force = ... N [1]

(c) **(i)** For the collision in **(b)** between the ball and the wall, state how the following apply:

1. Newton's third law,

.....

.....

.....

..... [2]

2. the law of conservation of momentum.

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..... [1]

(ii) State, with a reason, whether the collision is elastic or inelastic.

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..... [1]

4 **(a)** State Newton's first law.

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..... [1]

(b) A log of mass 450 kg is pulled up a slope by a wire attached to a motor, as shown in Fig. 3.1.

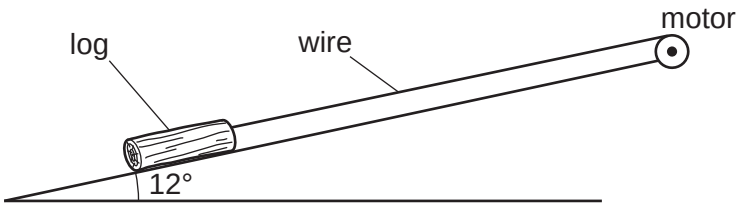

Fig. 3.1

The angle that the slope makes with the horizontal is 12°. The frictional force acting on the log is 650 N. The log travels with constant velocity.

(i) With reference to the motion of the log, discuss whether the log is in equilibrium.

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..... [2]

(ii) Calculate the tension in the wire.

tension = ... N [3]

(iii) State and explain whether the gain in the potential energy per unit time of the log is equal to the output power of the motor.

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..... [2]

5 **(a)** Explain the differences between the quantities *distance* and *displacement.*

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.....[2]

(b) State Newton's first law.

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.....[1]

(c) Two tugs pull a tanker at constant velocity in the direction XY, as represented in Fig. 1.1.

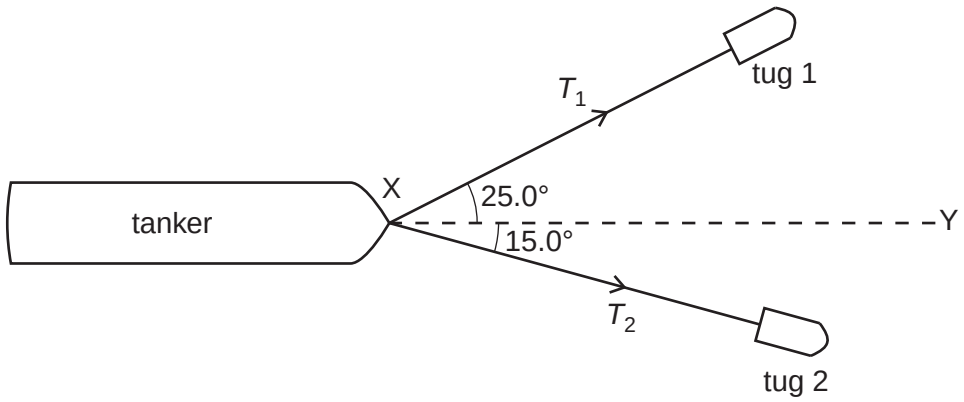

Fig. 1.1

Tug 1 pulls the tanker with a force T_1 at 25.0° to XY. Tug 2 pulls the tanker with a force of T_2 at 15.0° to XY. The resultant force R due to the two tugs is 25.0×10^3 N in the direction XY.

(i) By reference to the forces acting on the tanker, explain how the tanker may be described as being in equilibrium.

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.....[2]

(ii) **1.** Complete Fig. 1.2 to draw a vector triangle for the forces R, T_1 and T_2. [2]

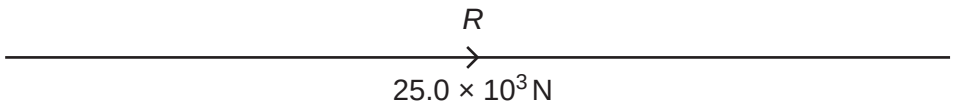

Fig. 1.2

2. Use your vector triangle in Fig. 1.2 to determine the magnitude of T_1 and of T_2.

T_1 = ... N

T_2 = ... N

[2]

6 **(a)** A sphere of radius R is moving through a fluid with constant speed v. There is a frictional force F acting on the sphere, which is given by the expression

$$F = 6\pi DRv$$

where D depends on the fluid.

(i) Show that the SI base units of the quantity D are $\text{kg m}^{-1}\text{ s}^{-1}$.

[3]

(ii) A raindrop of radius 1.5 mm falls vertically in air at a velocity of 3.7 m s^{-1}. The value of D for air is $6.6 \times 10^{-4}\text{ kg m}^{-1}\text{ s}^{-1}$. The density of water is 1000 kg m^{-3}.

Calculate

1. the magnitude of the frictional force F,

F = ... N [1]

2. the acceleration of the raindrop.

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

(b) The variation with time *t* of the speed *v* of the raindrop in **(a)** is shown in Fig. 2.1.

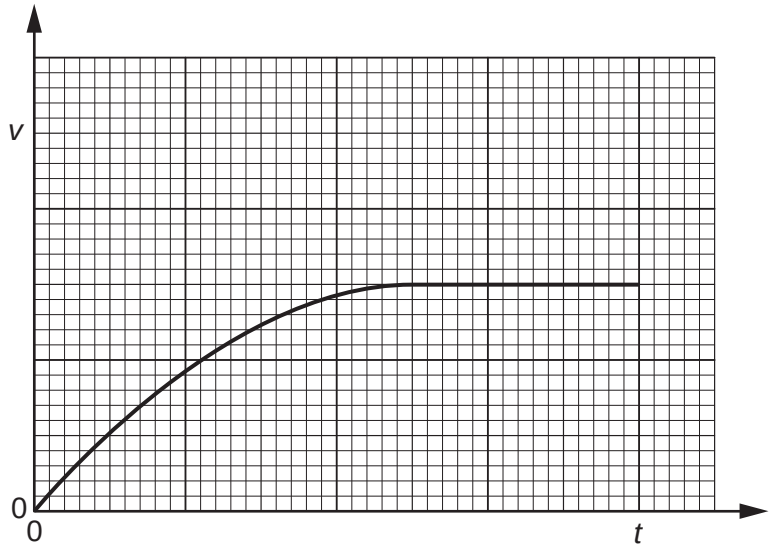

Fig. 2.1

(i) State the variation with time of the **acceleration** of the raindrop.

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..... [3]

(ii) A second raindrop has a radius that is smaller than that given in **(a)**. On Fig. 2.1, sketch the variation of speed with time for this second raindrop. [2]