

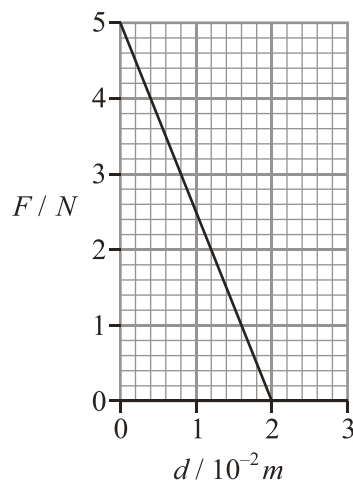
## WORK, ENERGY, POWER: IB Problems

1. An object of mass  $m_1$  has a kinetic energy  $K_1$ . Another object of mass  $m_2$  has a kinetic energy  $K_2$ . If the momentum of both objects is the same, the ratio  $\frac{K_1}{K_2}$  is equal to

- A.  $\frac{m_2}{m_1}$ .
- B.  $\frac{m_1}{m_2}$ .
- C.  $\sqrt{\frac{m_2}{m_1}}$ .
- D.  $\sqrt{\frac{m_1}{m_2}}$ .

(1)

2. The graph below shows the variation with displacement  $d$  of the force  $F$  applied by a spring on a cart.

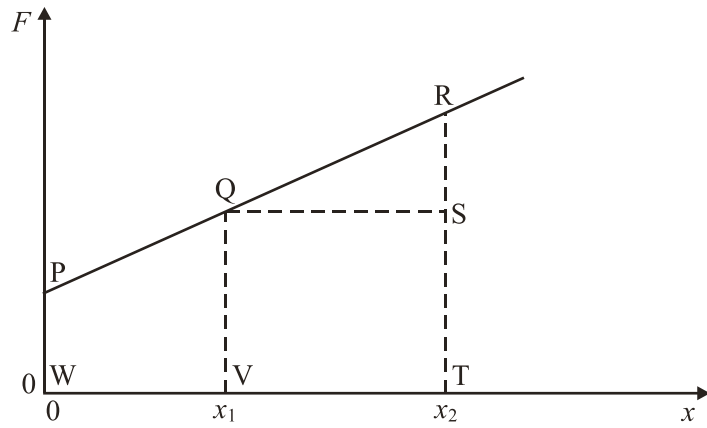


The work done by the force in moving the cart through a distance of 2 cm is

- A.  $10 \times 10^{-2} \text{ J}$ .
- B.  $7 \times 10^{-2} \text{ J}$ .
- C.  $5 \times 10^{-2} \text{ J}$ .
- D.  $2.5 \times 10^{-2} \text{ J}$ .

(1)

3. The diagram below shows the variation with displacement  $x$  of the force  $F$  acting on an object in the direction of the displacement.



Which area represents the work done by the force when the displacement changes from  $x_1$  to  $x_2$ ?

- A. QRS
- B. WPRT
- C. WPQV
- D. VQRT

(1)

4. This question is about the kinematics of an elevator (lift).

- (a) Explain the difference between the gravitational mass and the inertial mass of an object.

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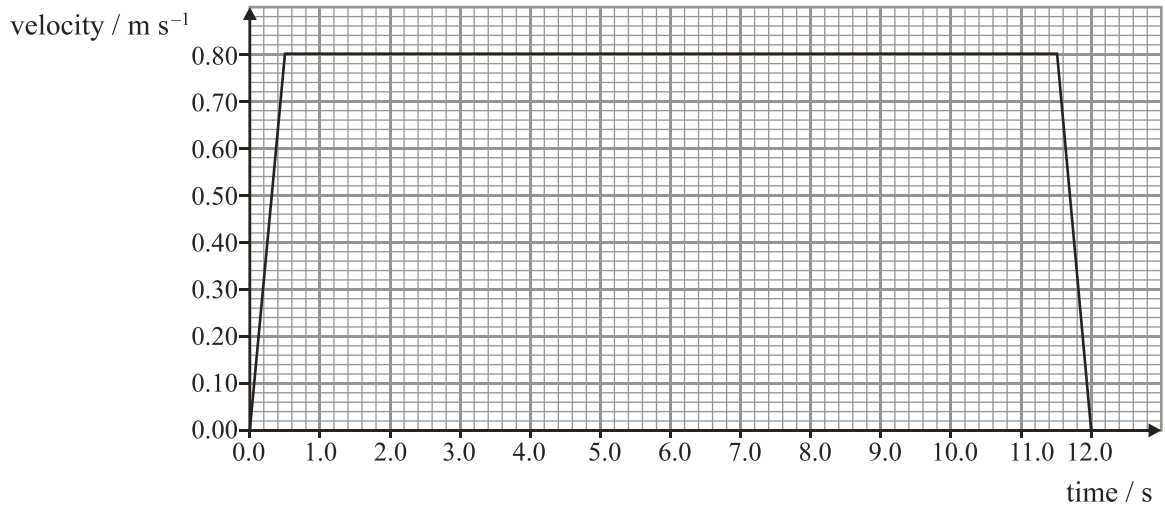
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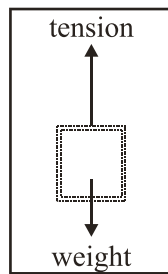
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(3)

An elevator (lift) starts from rest on the ground floor and comes to rest at a higher floor. Its motion is controlled by an electric motor. A simplified graph of the variation of the elevator's velocity with time is shown below.



The elevator is supported by a cable. The diagram below is a free-body force diagram for when the elevator is moving upwards during the first 0.50 s.



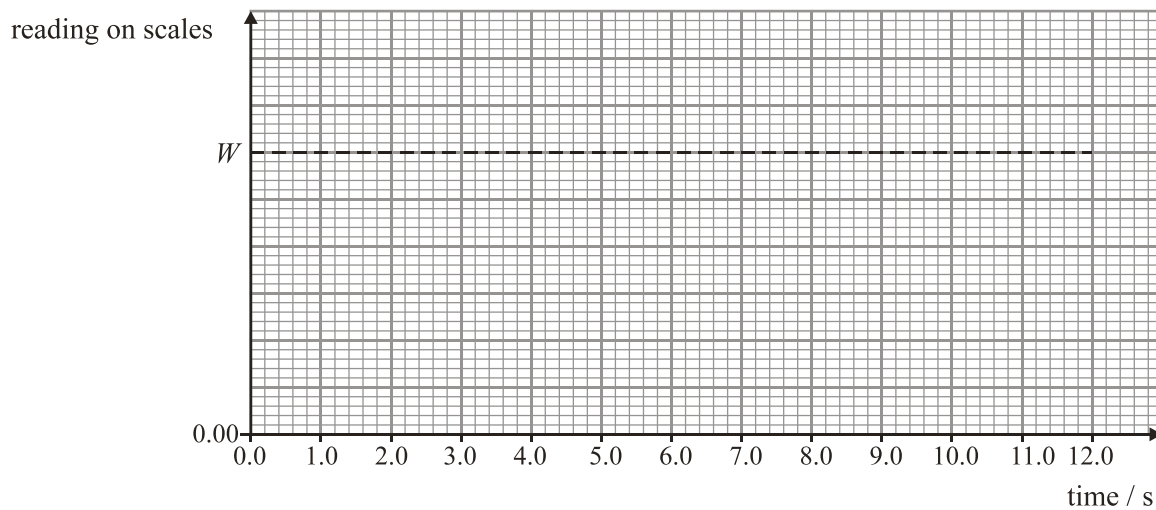
(b) In the space below, draw free-body force diagrams for the elevator during the following time intervals.

<p>(i) 0.50 to 11.50 s</p> <div style="text-align: center; margin-top: 20px;"> </div>	<p>(ii) 11.50 to 12.00 s</p> <div style="text-align: center; margin-top: 20px;"> </div>
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(3)

A person is standing on weighing scales in the elevator. Before the elevator rises, the reading on the scales is  $W$ .

- (c) On the axes below, sketch a graph to show how the reading on the scales varies during the whole 12.00 s upward journey of the elevator. (*Note that this is a sketch graph – you do not need to add any values.*)



(3)

- (d) The elevator now returns to the ground floor where it comes to rest. Describe and explain the energy changes that take place during the whole up and down journey.

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(4)

(Total 13 marks)

5. A machine lifts an object of weight  $1.5 \times 10^3 \text{ N}$  to a height of 10 m. The machine has an overall efficiency of 20%. The work done by the machine in raising the object is

- A.  $3.0 \times 10^3 \text{ J}$ .
- B.  $1.2 \times 10^4 \text{ J}$ .
- C.  $1.8 \times 10^4 \text{ J}$ .
- D.  $7.5 \times 10^4 \text{ J}$ .

(1)

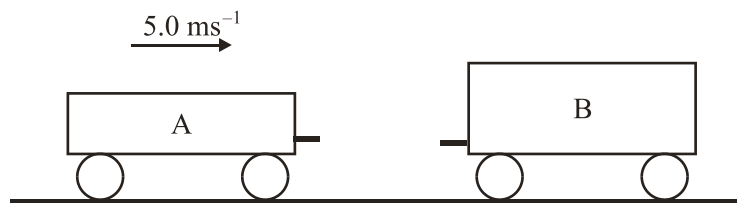
6. This question is about the collision between two railway trucks (carts).

(a) Define *linear momentum*.

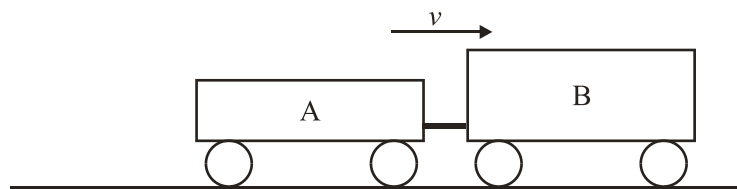
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(1)

In the diagram below, railway truck A is moving along a horizontal track. It collides with a stationary truck B and on collision, the two join together. Immediately before the collision, truck A is moving with speed  $5.0 \text{ ms}^{-1}$ . Immediately after collision, the speed of the trucks is  $v$ .



Immediately before collision



Immediately after collision

The mass of truck A is 800 kg and the mass of truck B is 1200 kg.

(b) (i) Calculate the speed  $v$  immediately after the collision.

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(3)

(ii) Calculate the total kinetic energy lost during the collision.

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(2)

(c) Suggest what has happened to the lost kinetic energy.

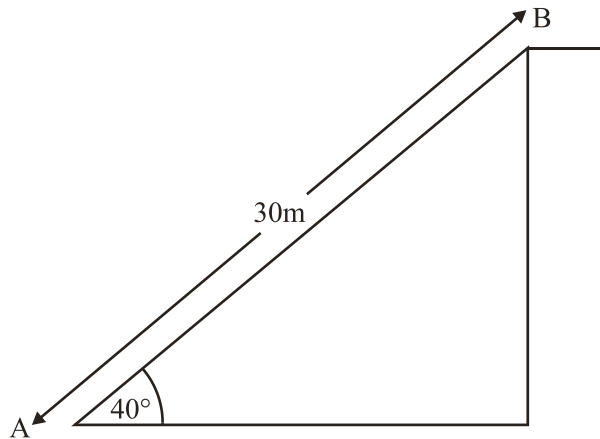
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(2)

(Total 8 marks)

7. This question is about estimating energy changes for an escalator (moving staircase).

The diagram below represents an escalator. People step on to it at point A and step off at point B.



(a) The escalator is 30 m long and makes an angle of  $40^\circ$  with the horizontal. At full capacity, 48 people step on at point A and step off at point B every minute.

(i) Calculate the potential energy gained by a person of weight  $7.0 \times 10^2$  N in moving from A to B.

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(2)

(ii) Estimate the energy supplied by the escalator motor to the people every minute when the escalator is working at full capacity.

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(1)

(iii) State **one** assumption that you have made to obtain your answer to (ii).

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(1)

The escalator is driven by an electric motor that has an efficiency of 70 %.

(b) Using your answer to (a) (ii), calculate the minimum input power required by the motor to drive the escalator.

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(3)

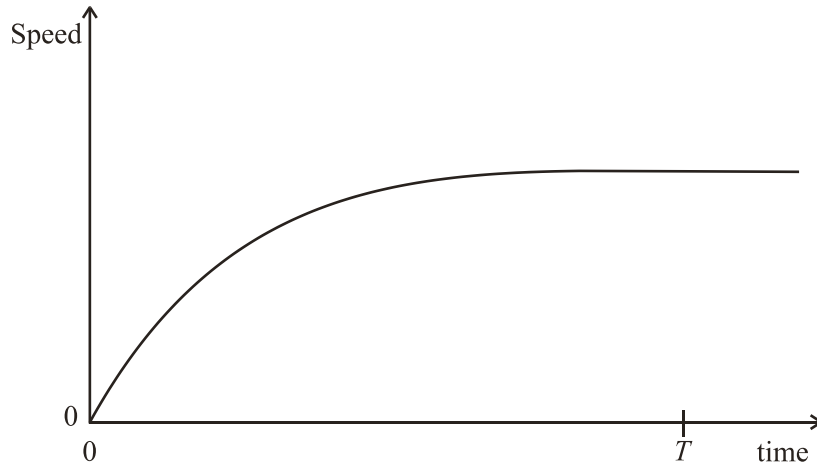
(Total 7 marks)

8. Which of the following quantities are conserved in an inelastic collision in an isolated system of two objects?

	Linear momentum of system	Kinetic energy of system
A.	Yes	Yes
B.	Yes	No
C.	No	Yes
D.	No	No

(1)

9. The variation with time of the vertical speed of a ball falling in air is shown below.



During the time from 0 to  $T$ , the ball gains kinetic energy and loses gravitational potential energy  $\Delta E_p$ . Which of the following statements is true?

- A.  $\Delta E_p$  is equal to the gain in kinetic energy.
- B.  $\Delta E_p$  is greater than the gain in kinetic energy.
- C.  $\Delta E_p$  is equal to the work done against air resistance.
- D.  $\Delta E_p$  is less than the work done against air resistance.

(1)