MOMENTUM

IB Physics HL

Dynamics - Set 1

A.2-A.4 | First assessment 2025 | Higher Level

Independent examination-style practice material

10 original problems

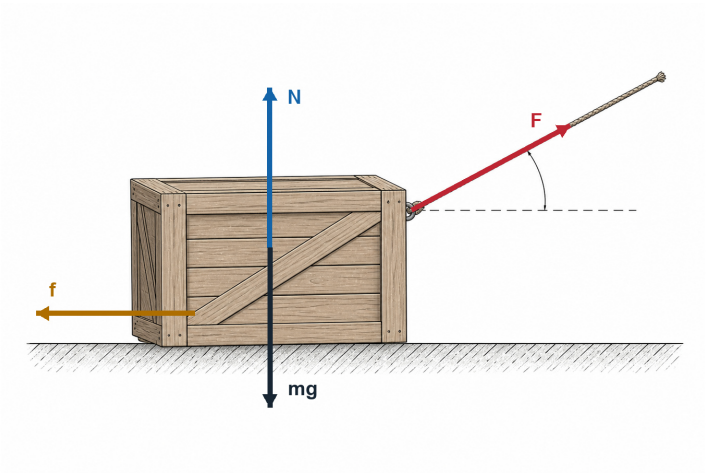
TASK 01

[1]

Pulling a crate at an angle

Paper 1A style | IB code A.2

A 12.0 kg crate rests on a horizontal floor. The coefficients of static and kinetic friction are 0.400 and 0.300. A force F acts at 30.0 degrees above the horizontal. Take g = 10.0 m s^{-2}.



What is the minimum F required to start the motion? A. 39.2 N B. 45.0 N C. 52.8 N D. 58.9 N

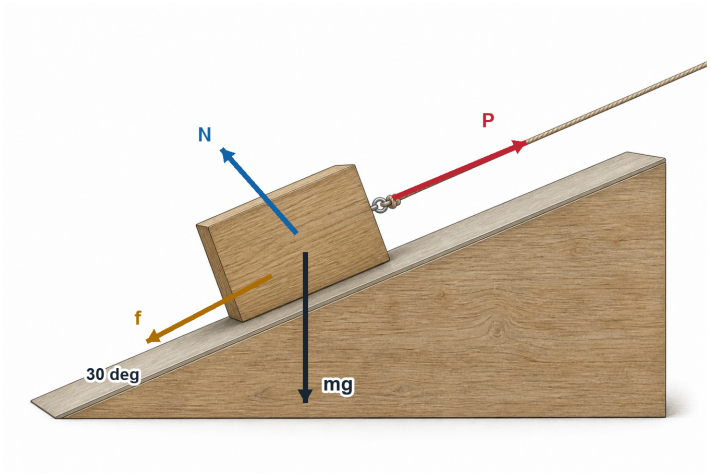
TASK 02

[7]

A block held on an incline

Paper 2 style | IB code A.2

An 8.00 kg block is on a plane inclined at 30.0 degrees. The coefficient of static friction is 0.200. A force P acts parallel to the plane towards its upper end. Take g = 10.0 m s^{-2}.



(a) Draw and label the forces acting on the block. [2]

(b) Determine the range of P for which the block remains at rest. [5]

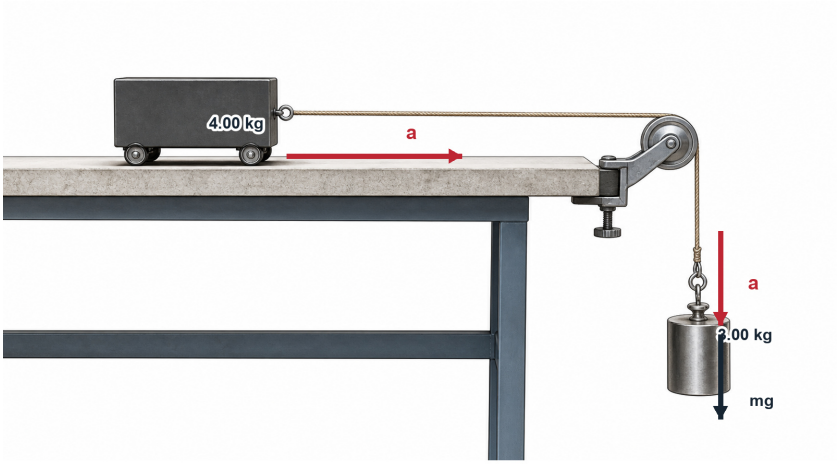
TASK 03

[6]

A block connected to a hanging mass

Paper 2 style | IB code A.2

A 4.00 kg block on a horizontal table is connected by a light string over an ideal pulley to a hanging 3.00 kg mass. The kinetic friction coefficient is 0.250. Take g = 10.0 m s^{-2}.



(a) Determine the acceleration of the system. [3]

(b) Determine the string tension. [2]

(c) State one assumption needed for both masses to have the same acceleration magnitude. [1]

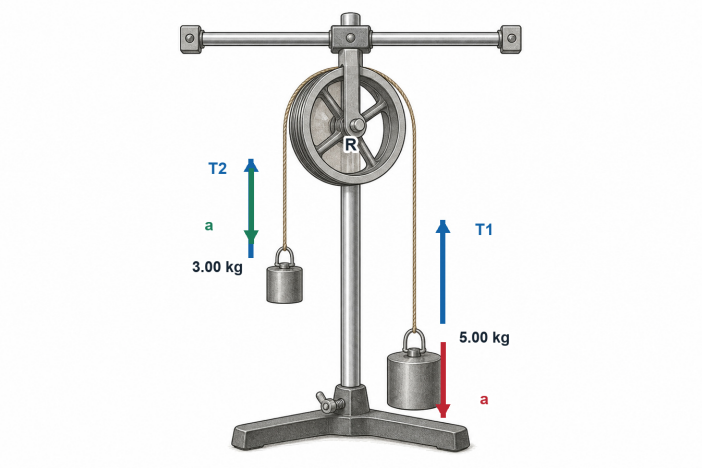
TASK 04

[8]

The rotational inertia of a pulley

Paper 2 style | IB code A.4

Masses of 5.00 kg and 3.00 kg hang on opposite sides of a pulley that is a uniform disk of mass 4.00 kg. The string does not slip and axle friction is negligible. Take g = 10.0 m s^{-2}.



(a) Explain why the tensions on the two sides are different. [2]

(b) Determine the acceleration. [3]

(c) Determine both tensions. [3]

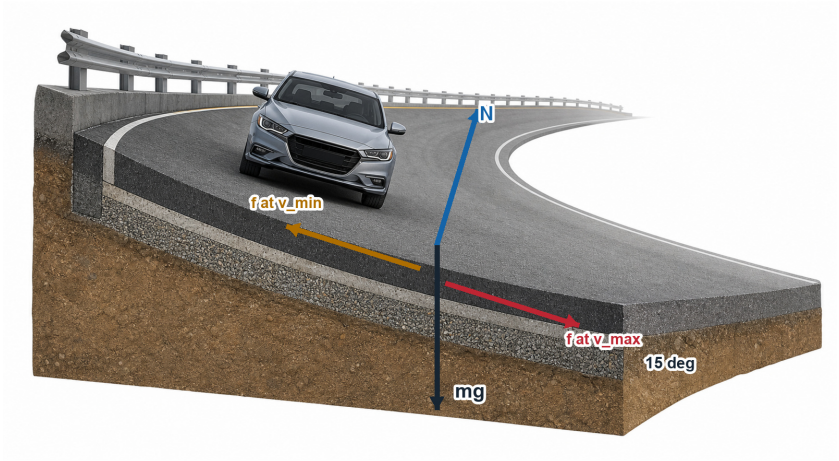
TASK 05

[8]

Speed limits on a banked curve

Paper 2 style | IB code A.2

A road curve of radius 50.0 m is banked at 15.0 degrees. The coefficient of static friction between tyres and road is 0.200. Take g = 10.0 m s^{-2}.



(a) Explain why friction acts in opposite directions at the minimum and maximum possible speeds. [2]

(b) Determine the minimum speed without slipping. [3]

(c) Determine the maximum speed without slipping. [3]

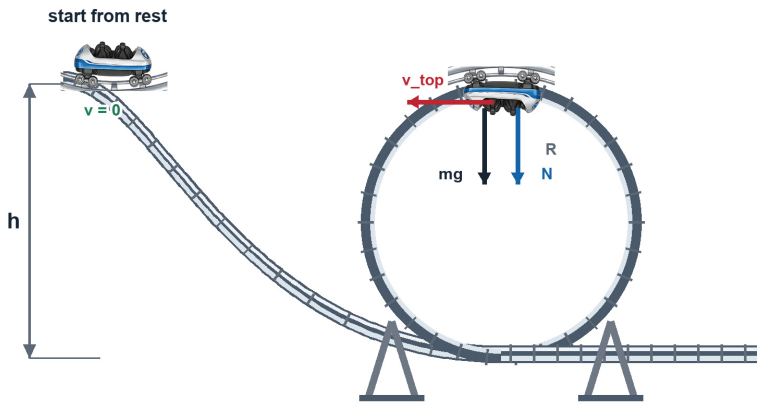
TASK 06

[1]

Maintaining contact in a vertical loop

Paper 1A style | IB code A.2, A.3

A small cart starts from rest at height h above the bottom of a frictionless vertical loop of radius R.



What is the minimum h for which the cart maintains contact at the top? A. 2R B. 5R/2 C. 3R D. 7R/2

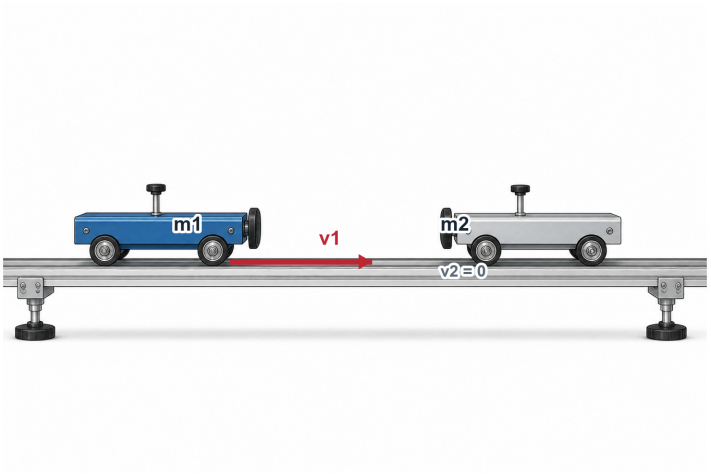
TASK 07

[8]

Collision followed by sliding

Paper 2 style | IB code A.2, A.3

A 2.00 kg cart travelling at 6.00 m s^{-1} collides with and sticks to a stationary 3.00 kg cart. The combined carts then slide on a surface with kinetic friction coefficient 0.200. Take g = 10.0 m s^{-2}.



(a) Determine their speed immediately after the collision. [2]

(b) Determine the energy dissipated during the collision. [3]

(c) Determine the stopping distance. [3]

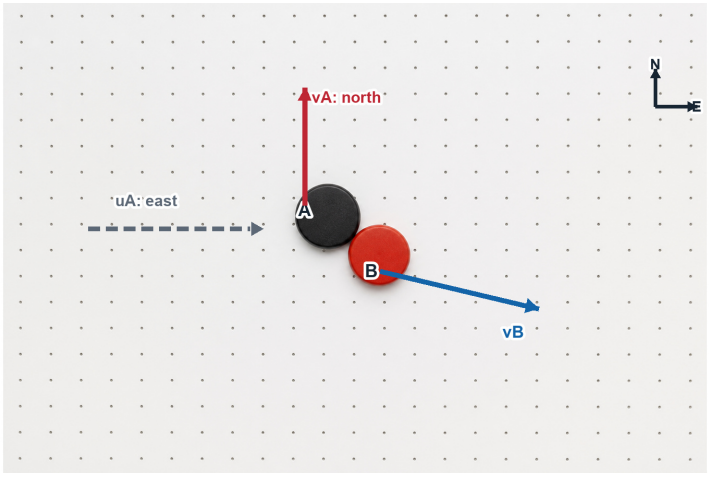
TASK 08

[7]

A two-dimensional collision

Paper 2 style | IB code A.2

Puck A, mass 0.200 kg, travels east at 5.00 m s^{-1} and collides with stationary puck B, mass 0.300 kg. After the collision A travels north at 2.00 m s^{-1}.



(a) Determine the east and north components of B's velocity. [4]

(b) Determine the magnitude and direction of B's velocity. [3]

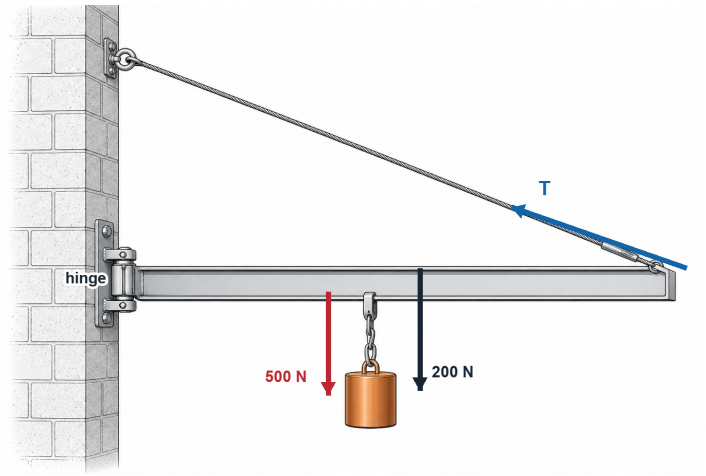
TASK 09

[8]

A beam supported by a cable

Paper 2 style | IB code A.4

A uniform horizontal beam is 4.00 m long and weighs 200 N. It is hinged to a wall. A cable at the free end makes 30.0 degrees with the beam. A 500 N load hangs 3.00 m from the hinge.



(a) Determine the cable tension. [3]

(b) Determine the horizontal and vertical components of the hinge force. [4]

(c) Explain why taking moments about the hinge is useful. [1]

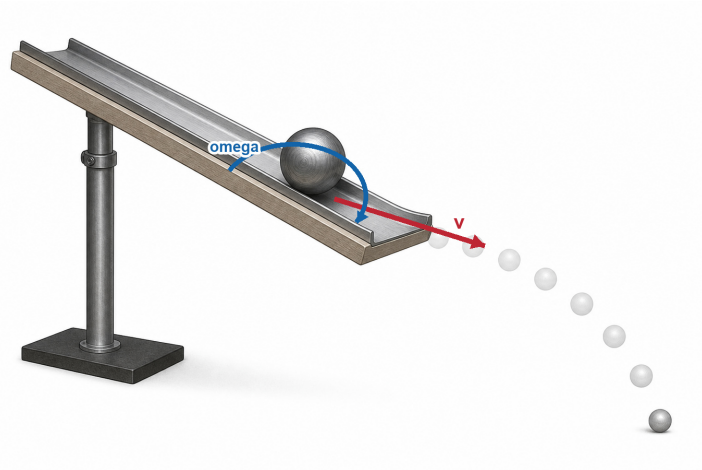
TASK 10

[7]

A solid sphere rolling down a slope

Paper 2 style | IB code A.3, A.4

A uniform solid sphere rolls without slipping from rest through a vertical height of 1.20 m on a plane inclined at 30.0 degrees. Take g = 10.0 m s^{-2} and I = 2MR^2/5.



(a) Determine its speed at the bottom. [3]

(b) Determine the acceleration of its centre of mass. [3]

(c) State the direction of the static friction force. [1]