

2.2 Forces

Question Paper

Course	DPIB Physics
Section	2. Mechanics
Topic	2.2 Forces
Difficulty	Medium

Time allowed: 80
Score: /62
Percentage: /100

Question 1a

Curling is a game played on a horizontal surface of ice. A player pushes a large smooth stone across the ice for several seconds and then releases it.

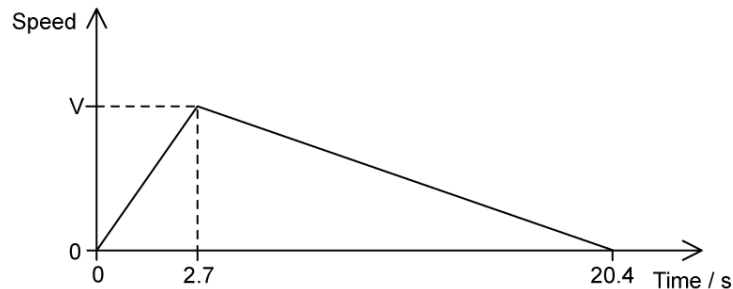
A 23.1 N force and 3.53 N force act on a stone of mass 19 kg at the same time.

- (a)
Calculate the magnitude of the maximum and minimum acceleration that can be experienced by the stone.

[2 marks]

Question 1b

The stone moves with a different set of forces until friction brings it to rest. The graph shows the variation of the stone's speed with time.



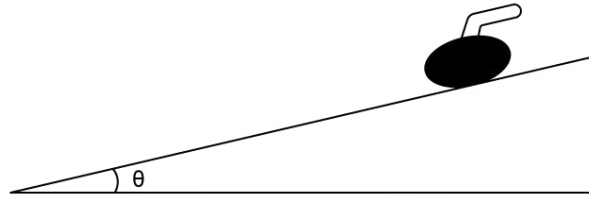
The total distance travelled by the stone is 35.1 m.

- (b)
Determine the coefficient of dynamic friction between the stone and the ice during the last 13.0 s of the stone's motion.

[4 marks]

Question 1c

The stone is now on an inclined plane at an angle θ to the horizontal where it is momentarily stationary.



(c)

Label the diagram to show the forces acting on the stone that act parallel and perpendicular to the plane. Your answer should include the name, the direction and point of application of each force.

[2 marks]

Question 1d

The stone slowly starts to move down the slope. The coefficient of dynamic friction on the inclined plane is 10 % less than that on the flat surface.

(d)

Determine the angle θ of the inclined plane to the horizontal.

[4 marks]

Question 2a

Ric is standing in an elevator and has a mass of 68 kg. The elevator is moving upwards at a speed of 2.5 m s^{-1} and comes to rest 3.0 s later.

- (a)
Calculate the reaction force on Ric from the elevator floor during the time it takes the elevator to come to rest.

[4 marks]**Question 2b**

Ric realises that he forgot his lab coat on the floor below. He again travels in the elevator which goes downwards at the same speed, coming to rest in the same time.

- (b)
Calculate the reaction force on Ric from the elevator floor during the time it takes to come to rest at the floor below.

[3 marks]

Question 2c

(c)

Hence, deduce which deceleration period of the elevator would make Ric feel:

- (i) Lighter
- (ii) Heavier

[2 marks]

Question 2d

In a serious stroke of bad luck, the elevator cable snaps and it falls freely. Ric experiences a sense of weightlessness.

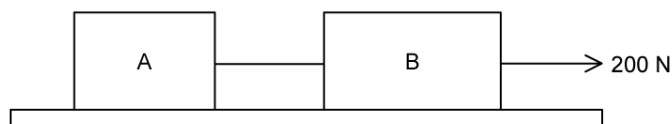
(d)

Explain, using appropriate laws of motion, why Ric feels a sense of weightlessness in this situation.

[3 marks]

Question 3a

Two blocks A and B are joined by a string and rest on a frictionless horizontal table. A force of 200 N is applied horizontally on block B.



(a)

Draw free-body diagrams for both boxes.

[3 marks]

Question 3b

Block A has a mass of 3.0 kg and block B has a mass of 7.0 kg.

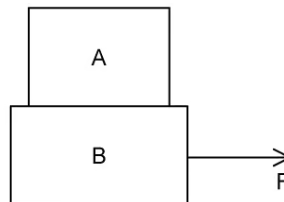
(b)

Calculate the acceleration of each block and the tension in the string.

[4 marks]

Question 3c

Block A is now placed on top of block B. The coefficient of static friction between the two blocks is 0.31. The bottom block is pulled with a horizontal force F .



(c)

Draw free-body diagrams for both boxes.

[3 marks]

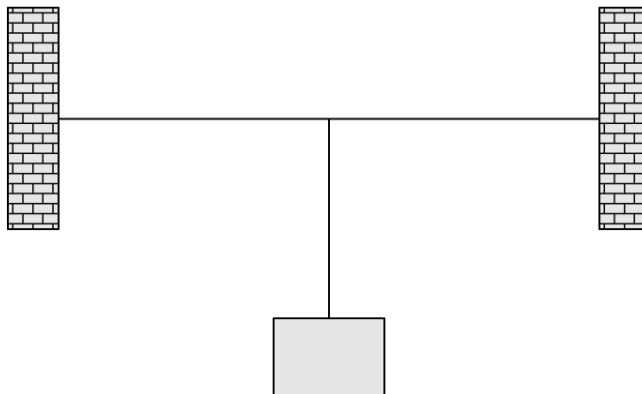
Question 3d

(d)
Calculate the magnitude of the maximum force F that will result in both blocks moving together without slipping.

[4 marks]

Question 4a

A mass is hung from two horizontal strings.

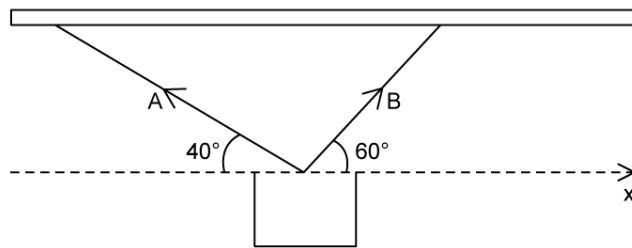


(a)
Outline why the mass will not remain in equilibrium when attached to the strings in this way.

[2 marks]

Question 4b

A flower pot of mass 15 kg hangs from two strings attached to the ceiling with tensions A and B, where it remains in equilibrium.



(b)

Derive two equations for A in terms of B. Give any values to an appropriate number of significant figures.

[4 marks]

Question 4c

(c)

Hence, calculate tensions A and B.

[4 marks]

Question 4d

A gardening enthusiast wants to hang a flower pot from two strings on the ceiling of their balcony. They have two pieces of string, but they are unfortunately quite old and frayed.

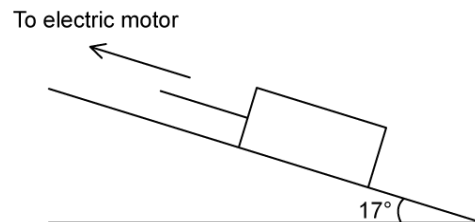
(d)

Suggest and explain how they can attach the strings to the flower pot in order for them to stay intact.

[2 marks]

Question 5a

A stone block is pulled at constant speed up an incline by a cable attached to an electric motor.



The incline makes an angle of 17° with the horizontal. The mass of the block is 180 kg and the tension T in the cable of 0.9 kN.

(a)

On the diagram draw and label arrows that represent the forces acting on the block.

[2 marks]

Question 5b

(b)

State the type of friction in this system and calculate the frictional force.

[4 marks]

Question 5c

(c)

Hence, calculate the appropriate coefficient of friction.

[3 marks]

Question 5d

The cable connecting the block to the electric motor abruptly breaks.

(d)

Calculate the acceleration of the block.

[3 marks]

