

1. Two particles P and Q have mass 0.4 kg and 0.6 kg respectively. The particles are initially at rest on a smooth horizontal table. Particle P is given an impulse of magnitude 3 N s in the direction PQ .

(a) Find the speed of P immediately before it collides with Q . (3)

Immediately after the collision between P and Q , the speed of Q is 5 m s⁻¹.

(b) Show that immediately after the collision P is at rest. (3)



2. At time $t = 0$, a particle is projected vertically upwards with speed $u \text{ m s}^{-1}$ from a point 10 m above the ground. At time T seconds, the particle hits the ground with speed 17.5 m s^{-1} . Find

(a) the value of u , (3)

(b) the value of T . (4)

Horizontal lines for student response.



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4. A car is moving along a straight horizontal road. The speed of the car as it passes the point *A* is 25 m s^{-1} and the car maintains this speed for 30 s. The car then decelerates uniformly to a speed of 10 m s^{-1} . The speed of 10 m s^{-1} is then maintained until the car passes the point *B*. The time taken to travel from *A* to *B* is 90 s and $AB = 1410 \text{ m}$.

(a) Sketch, in the space below, a speed-time graph to show the motion of the car from *A* to *B*.

(2)

(b) Calculate the deceleration of the car as it decelerates from 25 m s^{-1} to 10 m s^{-1} .

(7)



5.

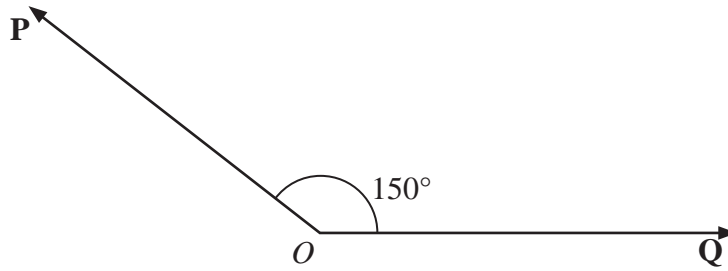


Figure 1

Two forces **P** and **Q** act on a particle at a point *O*. The force **P** has magnitude 15 N and the force **Q** has magnitude X newtons. The angle between **P** and **Q** is 150° , as shown in Figure 1. The resultant of **P** and **Q** is **R**.

Given that the angle between **R** and **Q** is 50° , find

(a) the magnitude of **R**, (4)

(b) the value of X . (5)



6.

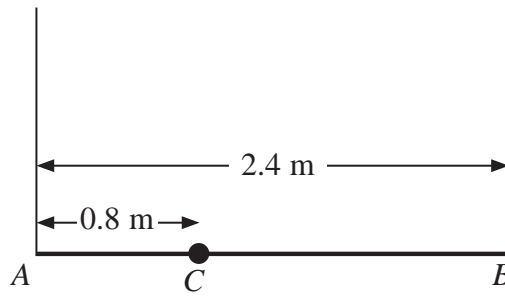


Figure 2

A plank AB has mass 12 kg and length 2.4 m. A load of mass 8 kg is attached to the plank at the point C , where $AC = 0.8$ m. The loaded plank is held in equilibrium, with AB horizontal, by two vertical ropes, one attached at A and the other attached at B , as shown in Figure 2. The plank is modelled as a uniform rod, the load as a particle and the ropes as light inextensible strings.

(a) Find the tension in the rope attached at B . (4)

The plank is now modelled as a non-uniform rod. With the new model, the tension in the rope attached at A is 10 N greater than the tension in the rope attached at B .

(b) Find the distance of the centre of mass of the plank from A . (6)



7.

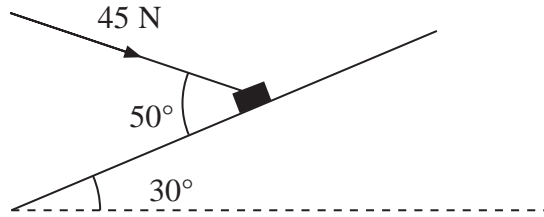


Figure 3

A package of mass 4 kg lies on a rough plane inclined at 30° to the horizontal. The package is held in equilibrium by a force of magnitude 45 N acting at an angle of 50° to the plane, as shown in Figure 3. The force is acting in a vertical plane through a line of greatest slope of the plane. The package is in equilibrium on the point of moving up the plane. The package is modelled as a particle. Find

- (a) the magnitude of the normal reaction of the plane on the package, (5)

- (b) the coefficient of friction between the plane and the package. (6)



8.

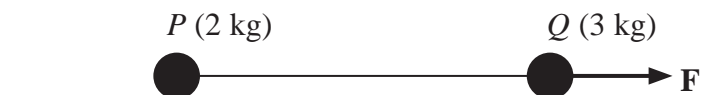


Figure 4

Two particles *P* and *Q*, of mass 2 kg and 3 kg respectively, are joined by a light inextensible string. Initially the particles are at rest on a rough horizontal plane with the string taut. A constant force **F** of magnitude 30 N is applied to *Q* in the direction *PQ*, as shown in Figure 4. The force is applied for 3 s and during this time *Q* travels a distance of 6 m. The coefficient of friction between each particle and the plane is μ . Find

- (a) the acceleration of *Q*, (2)
- (b) the value of μ , (4)
- (c) the tension in the string. (4)
- (d) State how in your calculation you have used the information that the string is inextensible. (1)

When the particles have moved for 3 s, the force **F** is removed.

- (e) Find the time between the instant that the force is removed and the instant that *Q* comes to rest. (4)
