Part I: Problems (*10 marks each*)

Solve all seven problems. Show all of your work, clearly and in order, to receive full marks. If you use a formula not given on the formula sheet, a derivation must be shown.

1. The initial position of a particle at $t = 0$ is *K15 10 (f) 1 (ormula) -31i281o8own.*

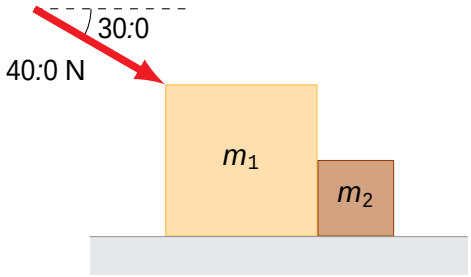
2. A ball is thrown towards a cli with an initial speed of 30:0 m/s directed at an angle of 60:0 above the horizontal. The ball lands on the edge of the cli 4:00 s after it is thrown.

   (a) What is the height of the cli ? (3 marks)

   (b) What is the maximum height reached by the ball? (4 marks)

   (c) What is the ball's impact velocity? (3 marks)

3. A 40.0 N force pushes two masses, m_1 = 8.00 kg and m_2 = 4.00 kg, across a horizontal surface. The force is directed 30.0 below the horizontal, as shown in the gure. The coe cient of kinetic friction between both masses and the surface is 0.150.

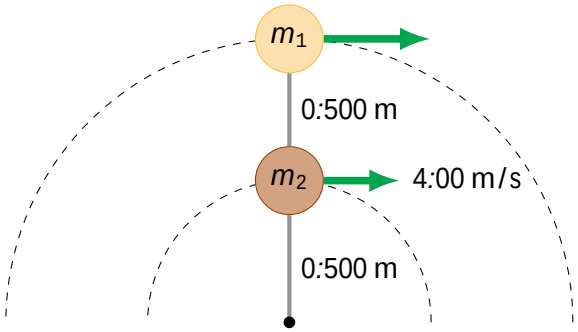


(a) Draw a free body diagram for each mass. (3 marks)

(b) What is the acceleration of the masses? (5 marks)

(c) What is the force that m_2 exerts on m_1? (2 marks)

4. A ball of mass $m_1 = 4{:}00\,\text{kg}$ is tied to another ball of mass $m_2 = 3{:}00\,\text{kg}$ by a string of length $0{:}500\,\text{m}$. The two balls are swung in a vertical circle by a second string of length $0{:}500\,\text{m}$ connected to m_2. As the balls rotate, the strings remain parallel. At the top if the circle, m_2 is moving at $4{:}00\,\text{m/s}$.



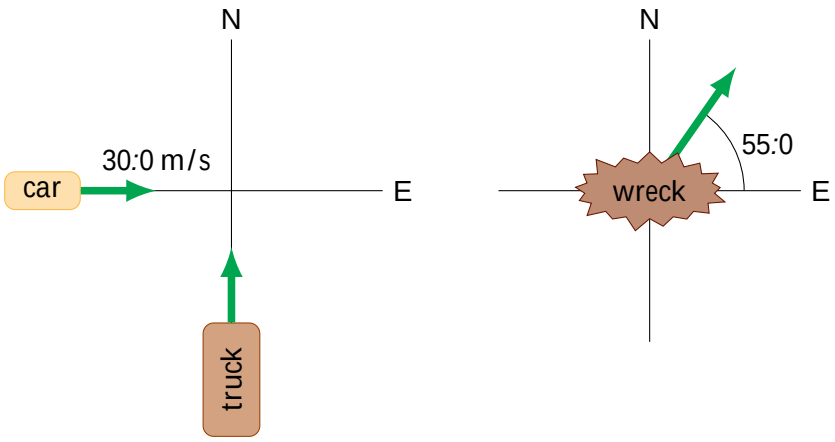
(a) Draw a free-body diagram for each mass at this instant. (3 marks)

(b) What is the tension in the string connecting the two balls at this instant? (4 marks)

(c) What is the tension in the string connecting m_2 to the centre of the circle at this instant? (3 marks)

5. The spring shown in the gure is compressed 50:0 cm and is used to launch the block, which has a mass of 100 kg. The surface is frictionless except for the nal 30:0 incline, where the coe cient of kinetic friction is 0:150.

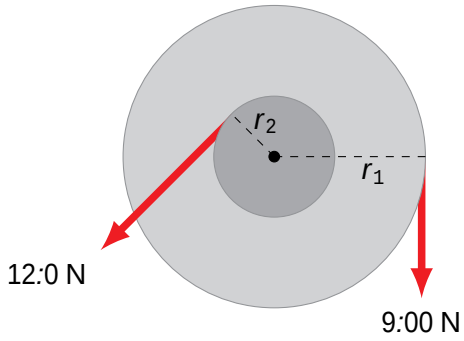
6. A 1000 kg car, travelling east at 30.0 m/s, collides with a 3000 kg truck, travelling north. After the collision, the vehicles stick together and the combined wreckage moves at 55.0 north of east.



(a) What is the speed of the truck before the collision? (7 marks)

(b) What percentage of the initial kinetic energy of the system is lost during the collision? (3 marks)

7. A solid wheel (made of two disks of di erent size) has a moment of inertia $I = 0.400\ \text{kg m}^2$. The wheel can rotate about a frictionless axle passing through its centre. A rope wrapped around the outer radius of the wheel exerts a tangential force of magnitude 9.00 N at a distance $r_1 = 0.250$ m from the axle. A second rope, wrapped around the inner radius of the wheel exerts a tangential force of magnitude 12.0 N at a distance $r_2 = 0.100$ m from the axle.

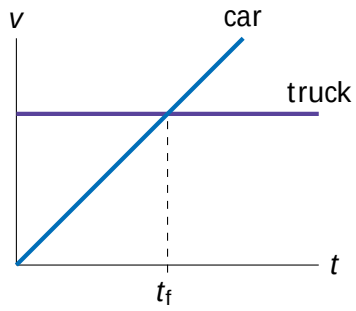


(a) What is the torque due to each force and the net torque acting on the wheel? (

Part II: Multiple Choice Questions (*2 marks each*)

Answer all fteen questions. Circle the best response from the choices given. If your nal selection is unclear you will not be given the marks. No marks will be awarded for diagrams, calculations, or reasoning.

1. The motions of a car and a truck along a straight road are represented by the velocity-time graph below. The two vehicles are side-by-side at time $t = 0$. At time t_f, which of the following statements is correct?



   (a) Both vehicles have travelled the same distance.
   (b) The truck has not moved at all.
   (c) The car has travelled further than the truck.
   (d) The truck has travelled further than the car.
   (e) No information about the distances travelled can be determined from this graph.

2. A package is dropped from a helicopter while the helicopter is moving upwards at 15 m/s. If it takes 25 s before the package strikes the ground, how high above the ground was the package when it was released?

   (a) 2:7 km
   (b) 3:4 km
   (c) 2:2 km
   (d) 3:2 km
   (e) None of the above.

3. If the scalar (dot) product of two vectors is negative, which of the following statements is correct?

   (a) There was a calculator error.
   (b) The angle between the vectors is between 0 and 90 .
   (c) The angle between the vectors is exactly 90 .
   (d) The angle between the vectors is between 270 and 360 .
   (e) The angle between the vectors is between 90 and 180 .

4. A physics student jumps up into the air o of a horizontal oor. How does the force exerted on the student by the oor compare to the student's weight?

   (a) The force of the oor is equal to the weight and in the same direction.
   (b) The force of the oor is equal to the weight and in the opposite direction.
   (c) The force of the oor is less than the weight and in the same direction.
   (d) The force of the oor is less than the weight and in the opposite direction.
   (e) The force of the oor is greater than the weight and in the opposite direction.

5. A cyclist rides up a 30 slope with a constant speed. Which of the following statements is correct?

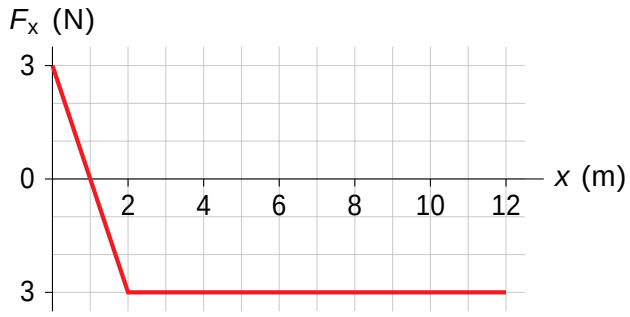
   (a) The net force acting on the bike (due to gravity, the normal force, and friction) points opposite to the direction of motion.
   (b) The net force acting on the bike (due to gravity, the normal force, and friction) points in the direction of motion.
   (c) The net force acting on the bike (due to gravity, the normal force, and friction) is zero.
   (d) None of the above statements is correct.

6. Three blocks are pushed across a frictionless surface. If the force P = 6:0 N, what is the magnitude of the force that the 3:0 kg block exerts on the 2:0 kg block?

   (a) 8:4 N
   (b) 7:2 N
   (c) 6:4 N
   (d) 5:6 N
   (e) 4:8 N

7.

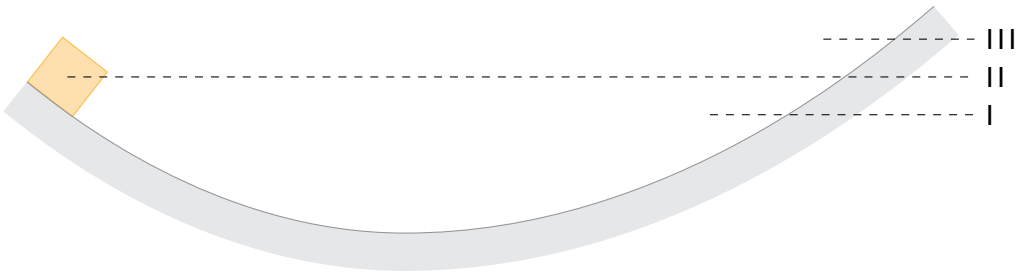
8. The only force acting on a 2:0 kg body as it moves along the x axis is shown in the gure. At $x = 0$ the body is already moving at 3:0 m/s in the positive x direction. At what value of x will the body momentarily come to rest?



(a) 3:0 m
(b) 5:0 m
(c) 7:0 m
(d) 9:0 m
(e) 12 m

9. A 40 g ball is launched at an unknown angle from point A at the top of a 30 m tall cli . The ball reaches a maximum height of 10 m above the top of the cli before falling to the ground

10. A box slides along the frictionless surface shown in the gure. At the position shown, the box is already moving down the slope. At which level on the other side will the box stop?



(a) Level III.

(b) Level II.

(c) Level I.

(d) The box will stop at the lowest point in the valley and never make it to the other side.

(e) It depends on the mass of the box.

11. Two objects of di erent mass collide. How do the impulses they exert on each other during the collision compare?

(a) They are are equal in magnitude and in direction.

(b) They are equal in magnitude and opposite in direction.

(c) They are equal in magnitude and opposite in direction, but only if it was an elastic collision.

(d) They are equal in magnitude and opposite in direction, but only if it was an inelastic collision.

(e) They are equal in magnitude and opposite in direction, but only if the objects have the same initial speed.

12. Car A is moving with a speed v

13. A rigid body is rotating with a uniform angular velocity. Which of the following statements is correct?

    (a) All points on the body have the same angular velocity and the same linear velocity

    (b) All points on the body have the same angular velocity, but di erent linear velocities

    (c) All points on the body have di erent angular velocities, but the same linear velocity

    (d) All points on the body have di erent angular velocities and di erent linear velocities

14. A child of mass 20 kg sits 140 cm to the left of the pivot point of a see-saw. Another child of mass 35 kg sits 80 cm to the right of the pivot point. Assuming the see-saw itself is massless, how will the see-saw rotate?

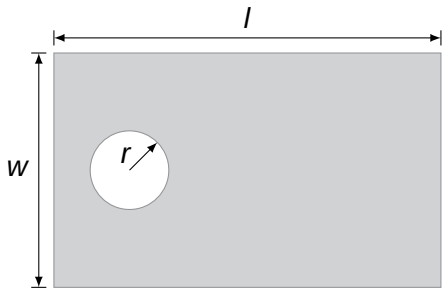
    (a) Counterclockwise.

    (b) Clockwise.

    (c) The see-saw will not rotate at all.

    (d) Not enough information is given to determine the sense of rotation.

15. The gure below shows a plate with a circle cut out of it. The dimensions have been measured to be: l = (5:12 0:04) cm, w = (3:10 0:03) cm, r = (0:52 0:01) cm. Accounting for the uncertainties in the measurements, how should the area of the plate be reported?



    (a) A = (15:02 0:05) cm^2

    (b) A = (15:02 0:09) cm^2

    (c) A = (15:0 0:2) cm^2

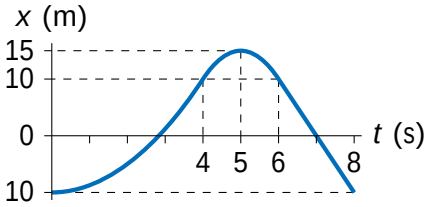
    (d) A = (15:0 0:3) cm^2

    (e) A = (15:0 0:8) cm^2

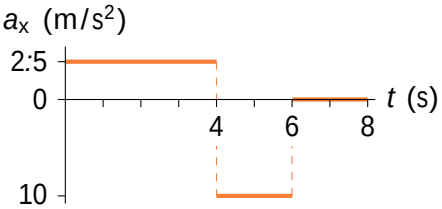
Answers

Problems

1. (a)



(b)



(c) 0 4 s and 5 6 s

2. (a) y = 25:5 m (b) y_{max} = 34:4 m (c) v = 20:0 m/s at 41:4 below the horizontal

3. (a) 6