

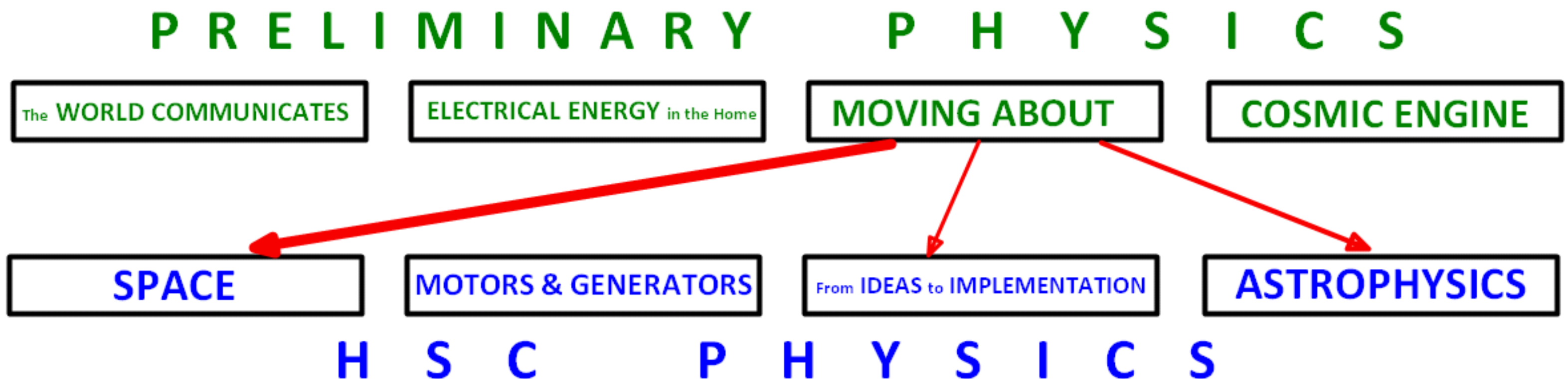
MODULE 3: MOVING ABOUT

NEWTON'S LAWS OF MOTION, CIRCULAR MOTION

PERIOD 3

3 AUGUST 2009

WEEK 2 / TERM 3 - MONDAY



MOVING ABOUT - 2

An analysis of the external forces on vehicles helps to understand the effects of acceleration and deceleration

Students learn to:

- describe the motion of one body relative to another
- identify the usefulness of using vector diagrams to assist solving problems
- explain the need for a net external force to act in order to change the velocity of an object
- describe the actions that must be taken for a vehicle to change direction, speed up and slow down
- describe the typical effects of external forces on bodies including:
 - friction between surfaces
 - air resistance
- define average acceleration as $a_{av} = \frac{\Delta v}{\Delta t}$ therefore $a_{av} = \frac{v - u}{t}$
- define the terms 'mass' and 'weight' with reference to the effects of gravity
- outline the forces involved in causing a change in the velocity of a vehicle when:
 - coasting with no pressure on the accelerator
 - pressing on the accelerator
 - pressing on the brakes
 - passing over an icy patch on the road
 - climbing and descending hills
 - following a curve in the road
- interpret Newton's Second Law of Motion and relate it to the equation $\Sigma F = ma$
- identify the net force in a wide variety of situations involving modes of transport and explain the consequences of the application of that net force in terms of Newton's Second Law of Motion

MOVING ABOUT - 2

An analysis of the external forces on vehicles helps to understand the effects of acceleration and deceleration

Students:

- analyse the effects of external forces operating on a vehicle
- gather first-hand information about different situations where acceleration is positive or negative
- plan, choose equipment or resources for and perform a first-hand investigation to demonstrate vector addition and subtraction
- solve problems using vector diagrams to determine resultant velocity, acceleration and force
- plan, choose equipment or resources for and perform first-hand investigations to gather data and use available evidence to show the relationship between force, mass and acceleration using suitable apparatus
- solve problems and analyse information using $\Sigma F = ma$ for a range of situations involving modes of transport
- solve problems and analyse information involving $F = \frac{mv^2}{r}$ for vehicles travelling around curves

NEWTON'S FIRST LAW OF MOTION

NEWTON'S SECOND LAW OF MOTION

22. A car of mass 1200 kg starts from rest on a horizontal road and a forward thrust of 10 000 N is applied. The resistance to motion due to road friction and air resistance totals 2500 N.

- Calculate the magnitude of the net force on the car.
- Calculate the magnitude of the acceleration of the car.
- Calculate the speed of the car after 5.0 s.
- Calculate the distance the car has travelled after 5.0 s.

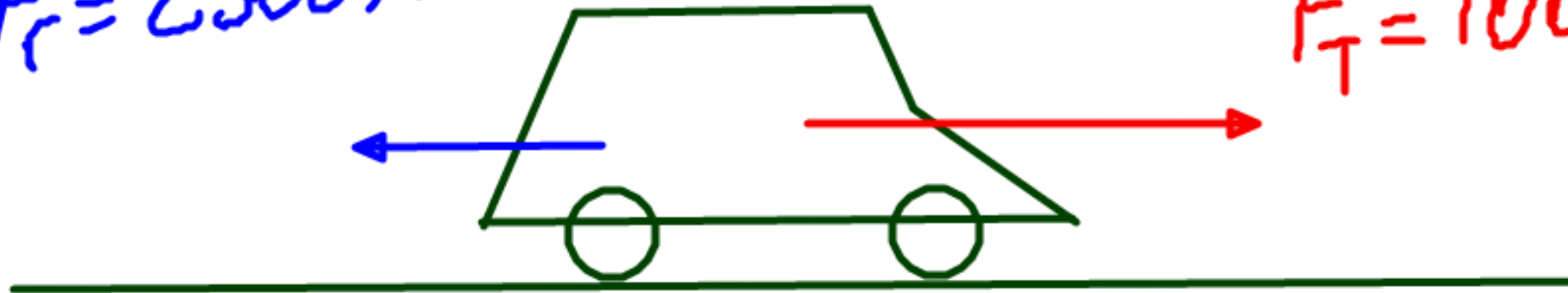
$$F_{\text{net}} = 7500 \text{ N}$$

$$a = \frac{F_{\text{net}}}{m} = 6.25 \text{ m/s}^2$$



$$F_r = 2500 \text{ N}$$

$$F_T = 10000 \text{ N}$$



$$u = 0$$

$$v = ?$$

$$a = 6.25$$

$$t = 5 \text{ s}$$

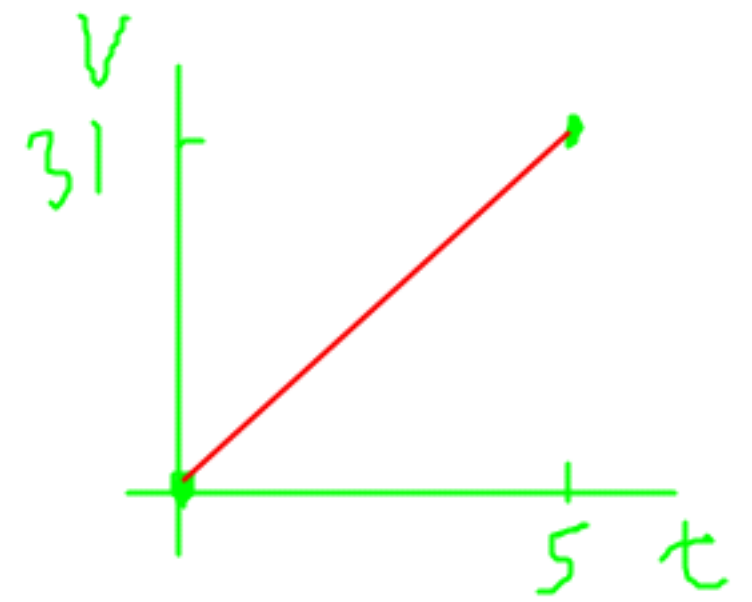
$$x = ?$$

$$v = u + at$$

$$= 0 + 6.25 \times 5$$

$$= 31.25 \text{ m/s}$$

$$x = 0 + \frac{1}{2} 6.25 \times 5^2 = 78 \text{ m}$$

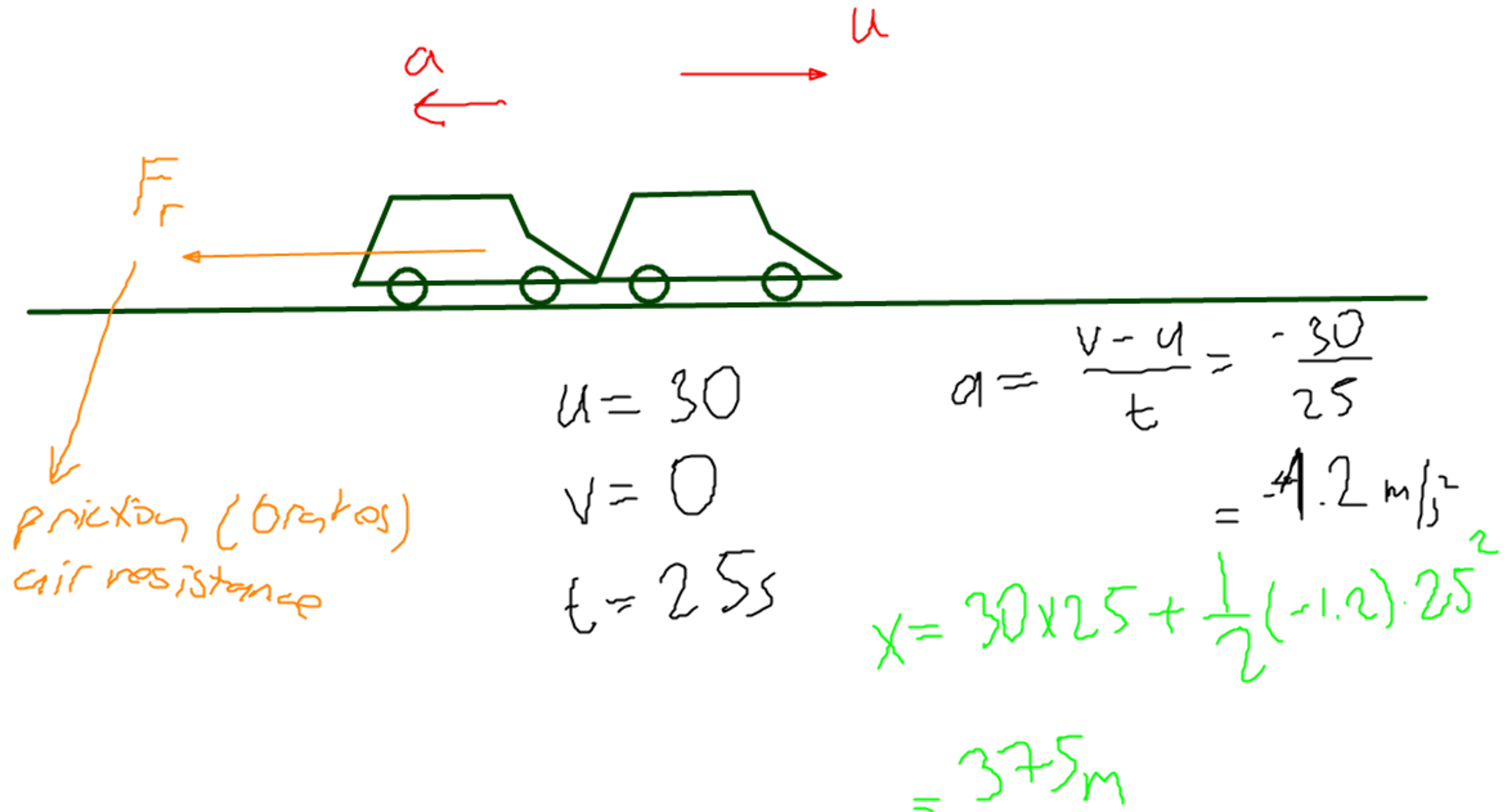


23. A train of mass 8.0×10^6 kg, travelling at a speed of 30 m s^{-1} , brakes and comes to rest in 25 s with a constant deceleration.

(a) Calculate the frictional force acting on the train while it is decelerating.

(b) Calculate the stopping distance of the train.

$$F = m \cdot a = 8 \times 10^6 \times 1.2 \\ = 9.6 \times 10^6 \text{ N}$$

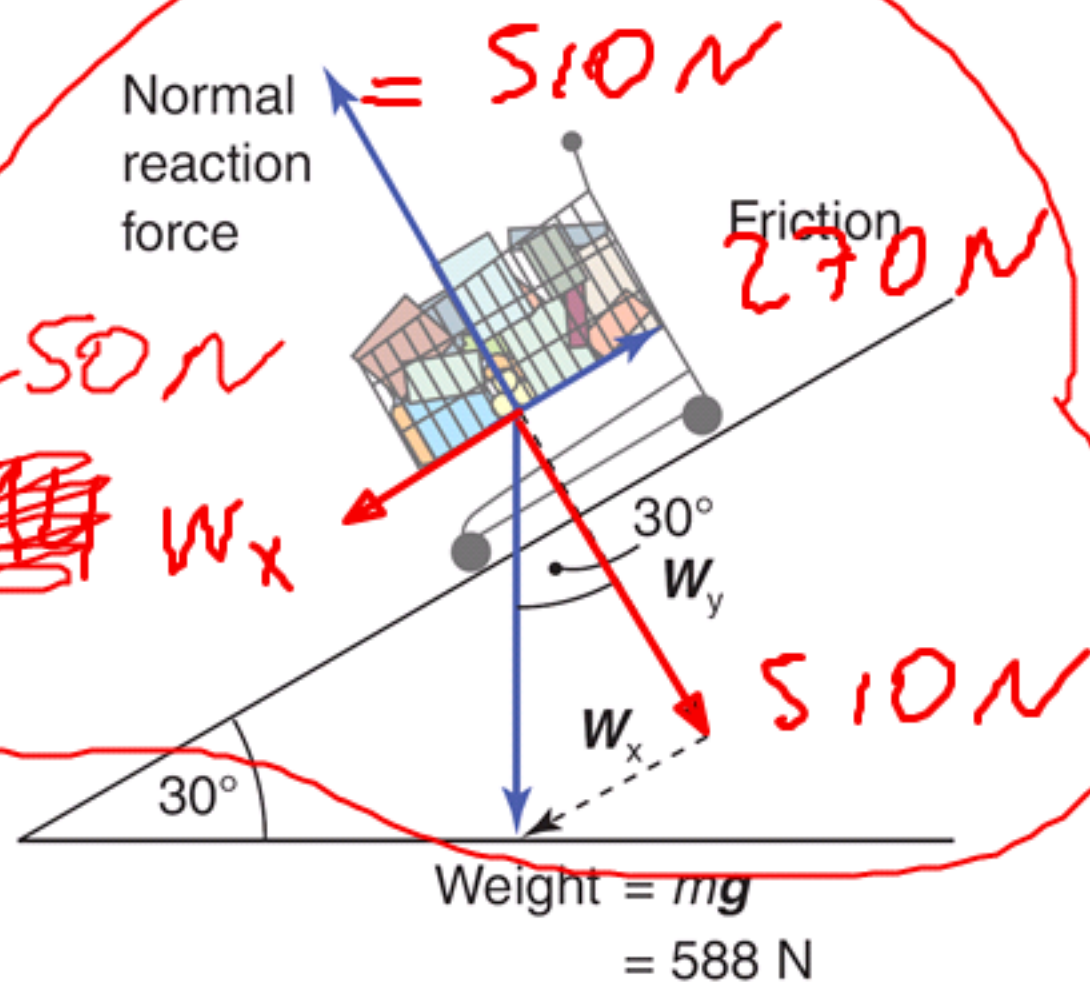


10.8 Speed and distance calculations

A loaded supermarket shopping trolley with a total mass of 60 kg is left standing on a footpath which is inclined at an angle of 30° to the horizontal. As the tired shopper searches for his car keys, he fails to notice that the loaded shopping trolley is beginning to roll away. It rolls in a straight line down the footpath for 9.0 s before it is stopped by an alert (and very strong) supermarket employee. Find:

- the speed of the shopping trolley at the end of its roll
- the distance covered by the trolley during its roll.

Assume that the footpath exerts a constant friction force of 270 N on the runaway trolley.



W_x = component of weight parallel to slope

W_y = component of weight perpendicular to slope

$$= W \cdot \sin 30 = 294 \text{ N}$$

$$\rightarrow W \cdot \cos 30 = 510 \text{ N}$$

$$F_{\text{net}} = 294 - 270 = 24 \text{ N}$$

$$a = \frac{24 \text{ N}}{60} = 0.4 \text{ m/s}^2$$

$$u = 0$$

$$v = ?$$

$$a = 0.4$$

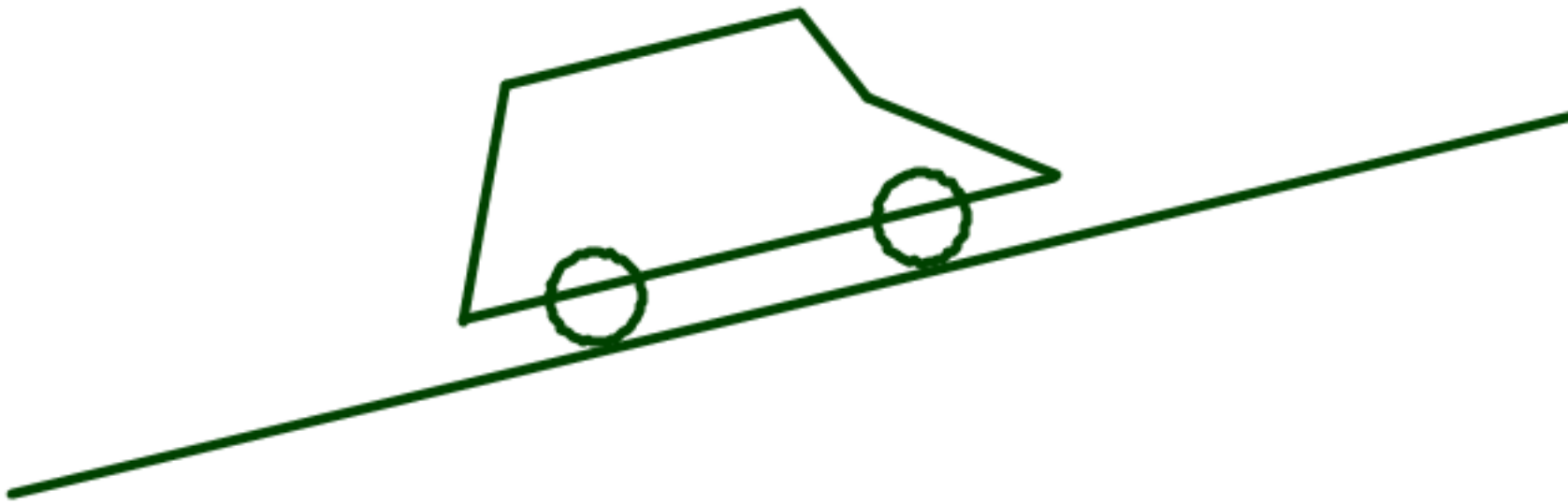
$$t = 9 \text{ s}$$

$$x = ?$$

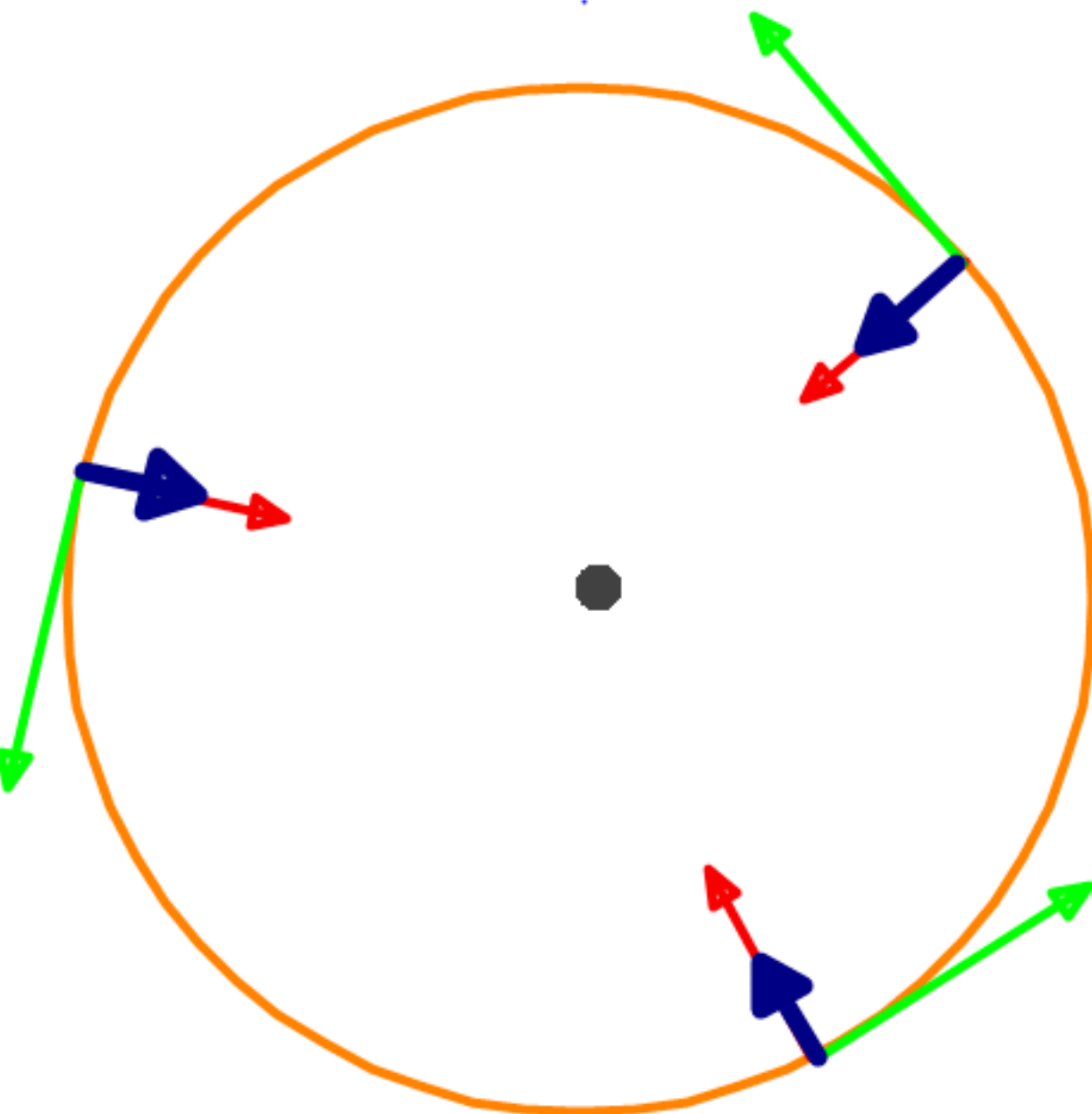
$$v = 3.6 \text{ m/s}$$

$$x = 16.2 \text{ m}$$

Example: A 1200-kg-car is travelling at constant velocity uphill on a slope of 15 degrees. If the total resistive forces is 25% of the weight for that particular speed, what must be the driving force and acceleration?



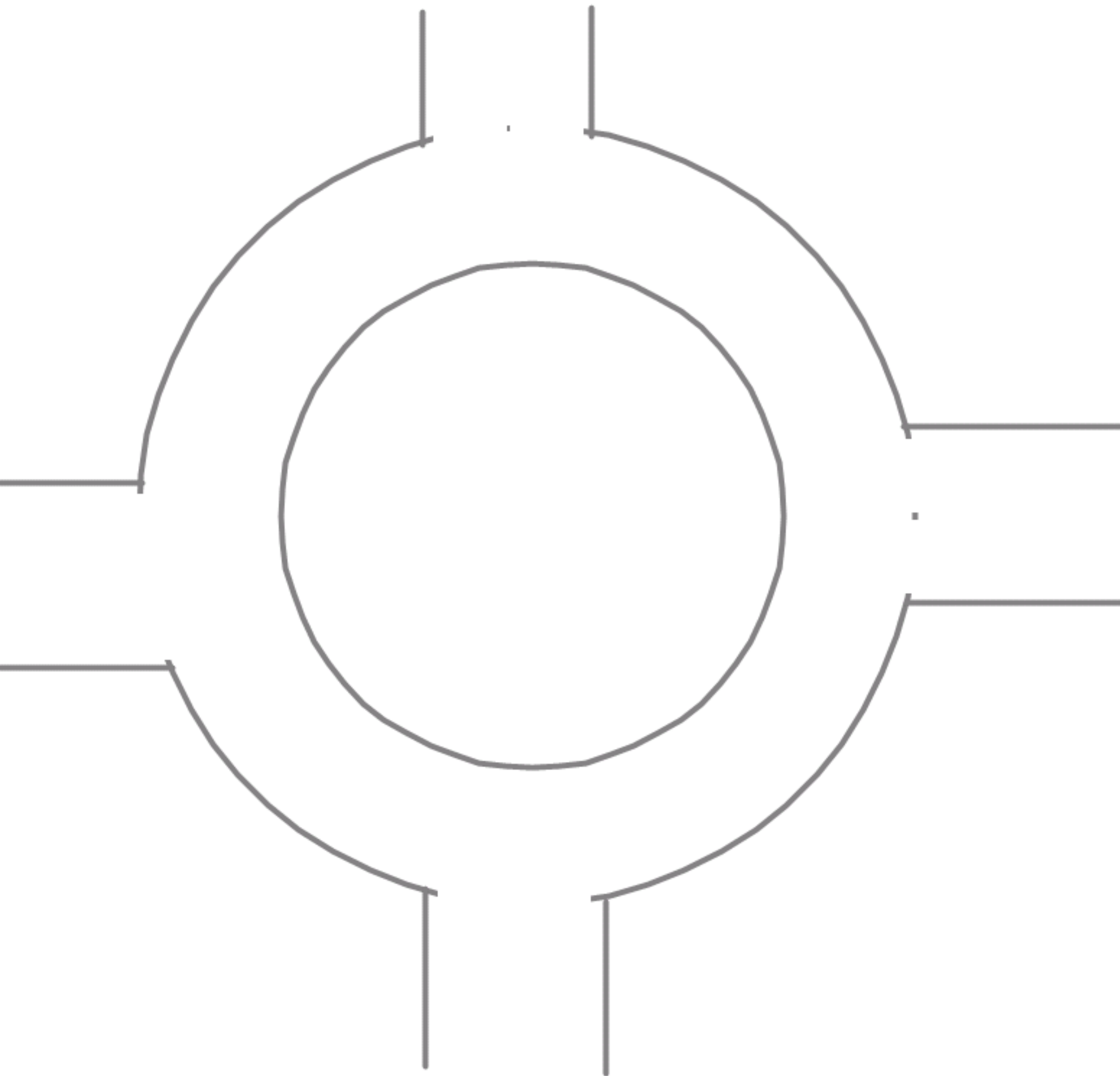
CIRCULAR MOTION



10.10 *Calculating acceleration and net force around a curve*

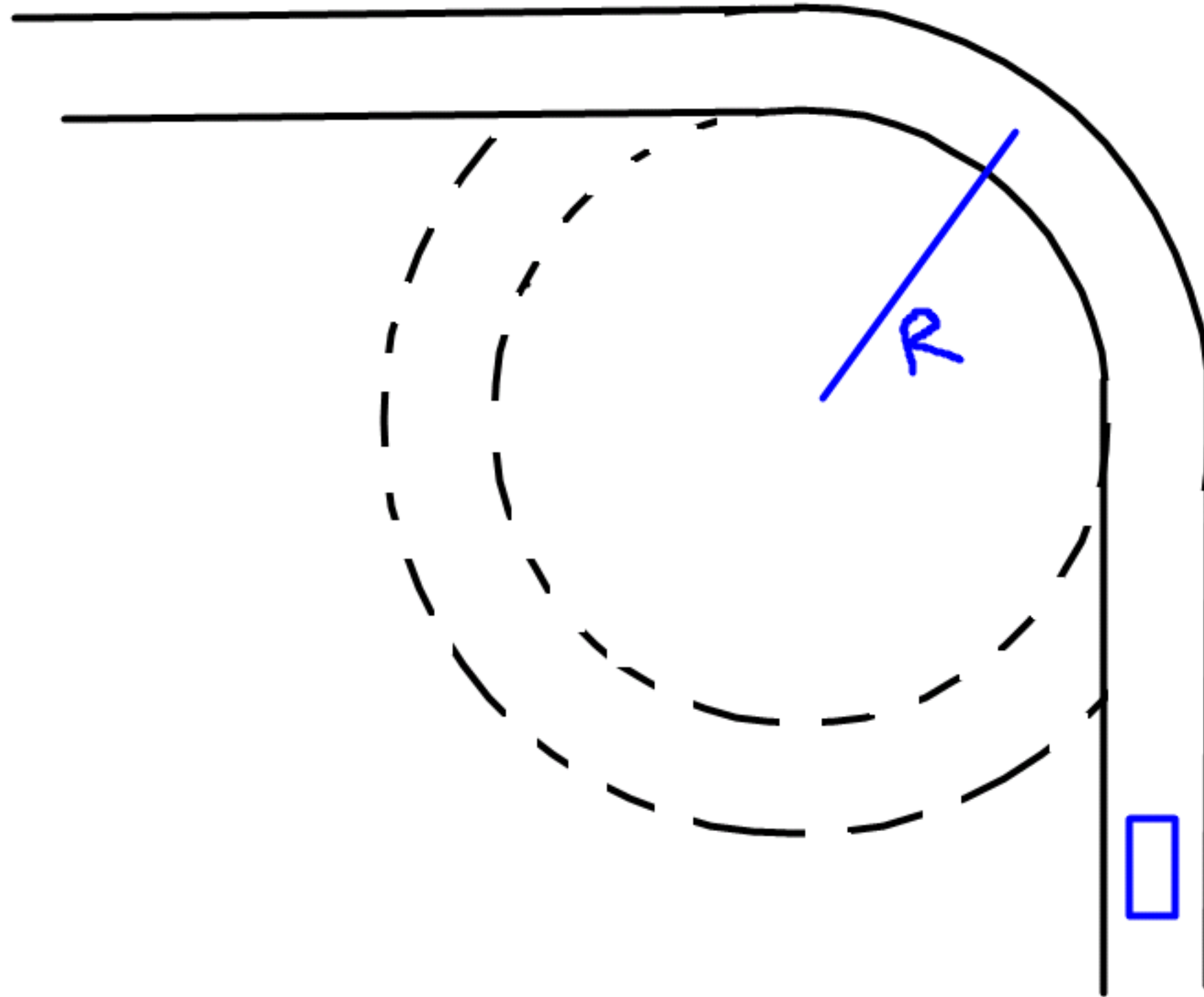
A car of mass 1200 kg is driven at a constant speed of 15 m s^{-1} around a curve with a radius of 12 m. Calculate:

- (a) the magnitude of acceleration of the car
- (b) the magnitude of net force acting on the car.

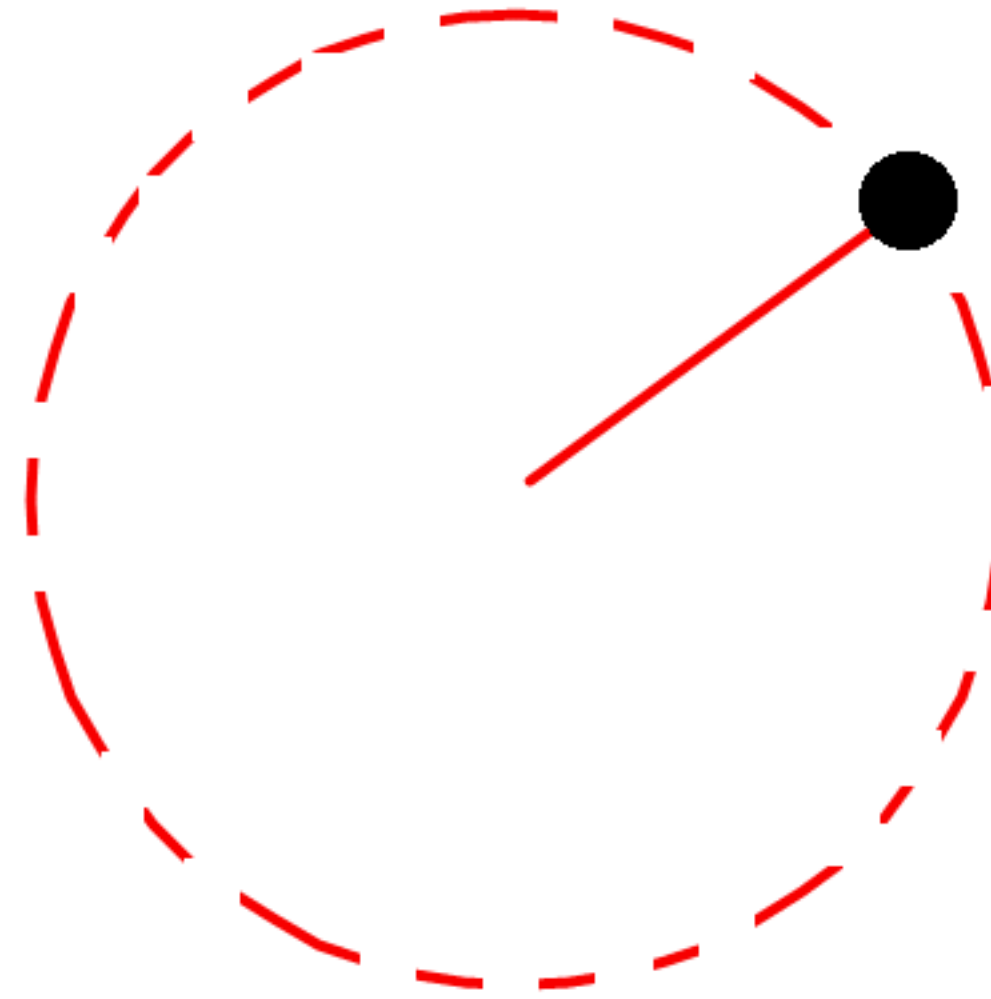


side view

Exercise 2: A car of mass 1450 kg is driven around a bend of radius 70 m. Determine the frictional force required between the tyres and the road in order to allow the car to travel at 70 km/h?



Exercise 1: A rock of mass 250 g is attached to the end of a 1.5 m long string and whirled in a horizontal circle at 15 m/s. Show the velocity, acceleration and net force on the rock and then calculate the centripetal force and acceleration of the rock.



SOURCES OF CENTRIPETAL FORCE

MOTION	F_c PROVIDED BY ...
Whirling rock on a string	The string
Electron orbiting atomic nucleus	Electron–nucleus electrical attraction
Car cornering	Friction between tyres and road
Moon revolving around Earth	Moon–Earth gravitational attraction
Satellite revolving around Earth	Satellite–Earth gravitational attraction

HOMEWORK

- ✦ Homework is an integral part of your "Learning Curve", take it seriously!
- ✦ If you cannot do all, at least do a few from each piece
- ✦ Target minimum 1 hour of Physics everyday
- ✦ Homework is due next period, unless otherwise stated

Apart from reading the relevant pages from the textbook your homework is:

- 1. Study pages 211 - 214 - Newton's 3rd Law**
- 2. Yellow Worksheet all questions**

3. log on to

**"<http://www.academicearth.org/courses/physics-i-classical-mechanics>"
and watch lecture 5 and 6**