PHYSICS YEAR 12

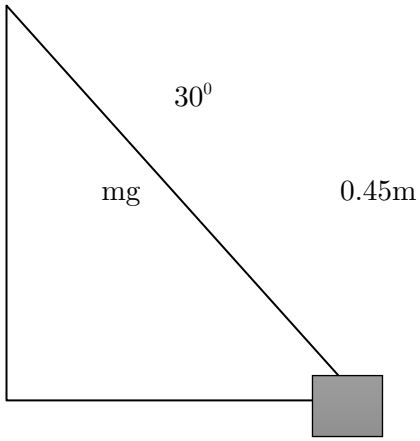
REVISION OF YEAR 11 WORK: Due: Monday Week 1: 2021

Revision – Conservation of Energy

Q: State the law of conservation of energy.

The total energy of an isolated system is constant. Energy can't be created nor destroyed, only transformed from one form to another or transferred from one system to another.

Q: If a 50g bob of a pendulum is pulled to one side to make 30^0 with the vertical and the length of the line is 45cm, what is the speed of the bob when the bob is allowed to fall and reach its lowest position?



$s_v = 0.45\cos30 = 0.390\text{m}$

$\Delta h = 0.45 - 0.390 = 0.060\text{m}$

$(\cancel{0.05})(9.8)(0.060) = \frac{1}{2}(\cancel{0.05})v^2$

$v = 1.09\text{ms}^{-1}$

Q: Write and simplify the equation for the above calculation.

$PE = KE$

$mgh = \frac{1}{2}mv^2$

$gh = \frac{1}{2}v^2$

Q: What height will the bob reach? Will it always reach this height? Explain.

Assuming no energy loss, the bob would reach the same height as it was initially released from. In reality, energy would be lost largely as heat due to drag and hence the bob would reach a height lower than it was initially released from, therefore the pendulum would eventually come to a stop.

Q: Consider a rollercoaster that is 120m above the ground travelling at 5 ms^{-1} when it falls through a drop to be 35 m above the ground.

[a] What is the coasters velocity at the bottom of the dip?

$\Delta h = 120 - 35 = 85m$

$PE + KE = KE$

$$m(9.8)(85) + \frac{1}{2}m(5)^2 = \frac{1}{2}mv^2$$

$$(9.8)(85) + 12.5 = \frac{1}{2}v^2$$

$v = 41.1ms^{-1}$

[b] If 10% of the energy is lost to heat what height will it reach on the other side and still be moving at 2.5 m/s?

$PE_i + KE_i = PE_f + KE_f$

$$0.9(m(9.8)(120) + \frac{1}{2}m25) = m(9.8)h + \frac{1}{2}m2.5^2$$

$$0.9((9.8)(120) + 12.5) = (9.8)h + \frac{1}{2}2.5^2$$

$h = 1.09 \times 10^2 m$

[c] Write the general equation for [a] and [b].

$$gh + \frac{1}{2}v^2 = gh + \frac{1}{2}v^2$$

Q: Write the efficiency equation.

$$\text{Efficiency} = \frac{Useful\ output}{Total\ input} \times 100$$

Q: What form of energy is "degraded energy"? What is meant by this term?

Degraded energy refers to the heat energy lost to the environment. This dispersed energy, the kinetic energy of the vibration of particles, is a very common waste product and is difficult to make use of

Q: What did you choose as your frame of reference in:

[a] The pendulum.

The lowest point that the bob reaches.

[b] The rollercoaster.

Ground level.

Q: What is the theoretical maximum speed of a rollercoaster car starting at a height of 50.0m above the lowest point on the track?

PE = KE

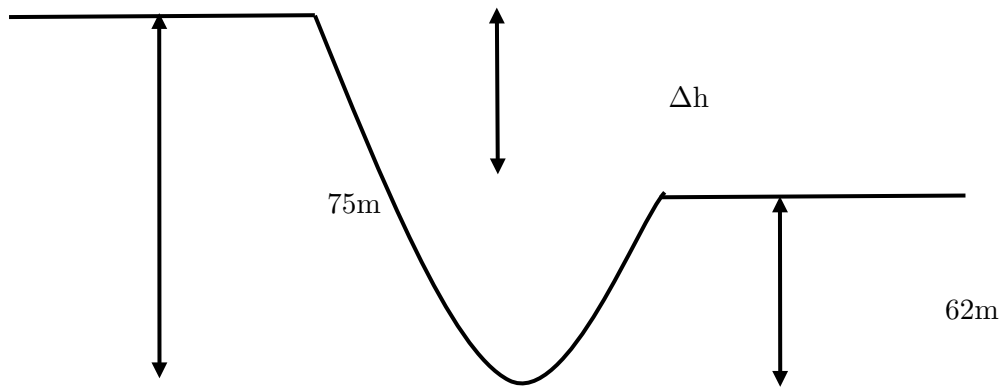
$m(9.8)(50) = \frac{1}{2}mv^2$

$(9.8)(50) = \frac{1}{2}v^2$

$v = 31.3ms^{-1}$

Q: A 900.0kg roller coaster car starts its run 75.0 m above the ground, and rolls to a height of 62.0 m up a smooth U-shaped track before slowing to a stop.

[a] How much energy has been lost due to friction and other causes?



$\Delta h = 75 - 62 = 13m$

$PE = (900)(9.8)(13) = 1.15 \times 10^5 J$

[b] The owner of the fairground wants a roller coaster that will travel at 100.0 km/h at the bottom of the first hill. How high will it need to start? Ignore friction.

$\frac{1}{2}m(\frac{100}{3.6})^2 = m(9.8)h$

$h = 39.4m$

[c] Will you travel faster, slower or at the same maximum speed if you are the only person on a rollercoaster ride, compared with sharing the ride with nine other people. Ignore frictional effects.

Same.

Revision – Vectors

Q: Compare vectors and scalars.

Vectors contain magnitude and direction.

Scalars contain just magnitude.

Q: List 5 examples each of scalars and vectors.

Scalars:	Vectors:
Mass	Force
Work	Velocity
Distance	Acceleration
Speed	Displacement
Pressure	Momentum

Q: Compare true bearing and compass bearing with examples.

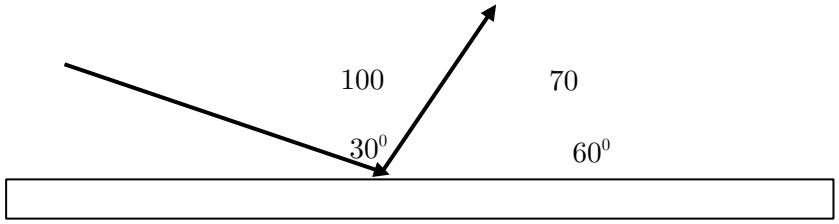
True bearing describes direction using a single 3-digit angle measured clockwise from north.

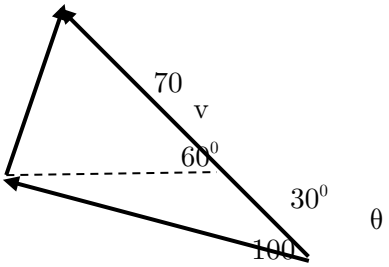
Compass bearing describes direction using a 2-digit angle deviation from north or south to east or west.

Q: A tennis ball moving at 5.00 ms^{-1} bounces straight back off a wall at 3.00 ms^{-1} Determine the balls change in velocity.

$\Delta v = v - u = 3 - (-5) = 8.00 ms^{-1}$ in the direction the ball was initially moving.

Q: A bullet ricochets off a wall striking the wall at 100km/h at 30^0 to the wall. The bullet leaves the wall at 70km/h at a 60^0 angle to the wall. Determine its change in velocity.





$v = \sqrt{100^2+70^2} = 122 kmh^{-1}$

$\theta = \tan^{-1}(0.7) = 35°$

Angle from wall $= 90 - 35 = 55°$

$v = 122 kmh^{-1}$ 55° from the wall

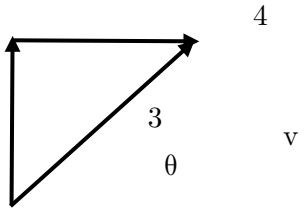
Q: You are applying a 60N force to your dog's leash at an angle of 40^0 to the horizontal. Find the component forces.

Vertical: $F_v = 60\sin 40 = 38.9N$ vertically

Horizontal: $F_h = 60\cos 40 = 46.0N$ horizontally

A motorboat traveling 4 m/s, East encounters a current traveling 3.0 m/s, North.

[a] What is the resultant velocity of the motorboat?

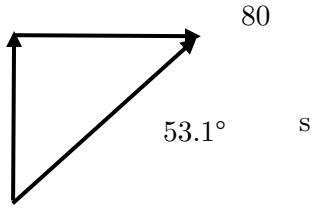


$v = \sqrt{25} = 5.00 ms^{-1}$

$\theta = \tan^{-1}(\frac{4}{3}) = 53.1°$

$v = 5.00 ms^{-1}\ 053.1°$

[b] If the width of the river is 80 meters wide, then how much time does it take the boat to travel shore to shore?



$\sin 53.1 = \frac{80}{s}$

$s = \frac{80}{\sin 53.1} = 100m$

$t = \frac{100}{5} = 2.00 \text{ x } 10s$

[c] What distance downstream does the boat reach the opposite shore?

$s = \frac{80}{\tan 53.1} = 6.00 \text{ x } 10m$

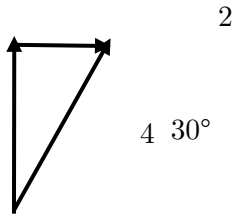
Q: A motorboat can travel at 4 m/s in still water.

[a] In which direction must the boat head if it reaches the other shore directly across from where it set off from, with the river moving at 2m/s.

$\sin^{-1}(\frac{2}{4}) = 30°$

Direction: 3.00 x 10° from the line perpendicular to the direction of the river

[b] What is the boats resultant velocity?



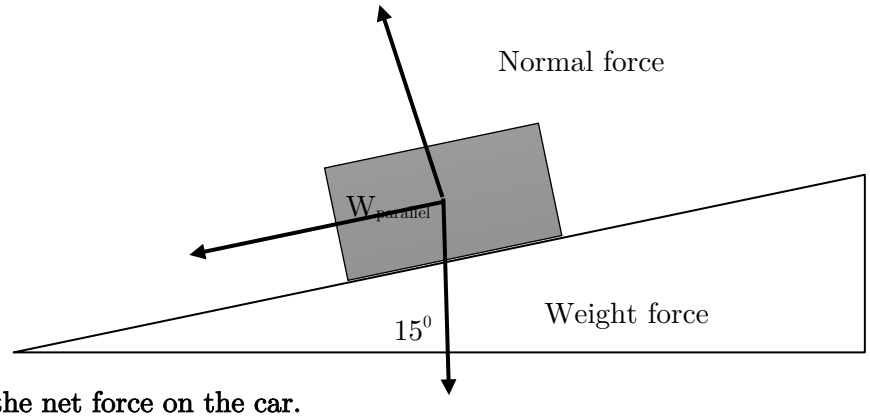
$$\tan 30 = \frac{2}{v}$$

$$\cos 30 = \frac{v}{4}$$

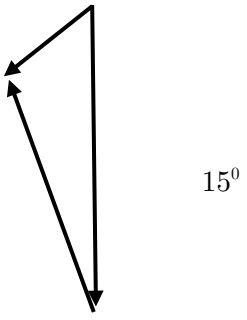
$$v = \frac{2}{\tan 30} = 3.46 ms^{-1}$$ directly across the river

Q: A 1 000 kg car is on a frictionless slope that is at an angle of 15^0 to the horizontal.

[a] Draw a diagram and draw in all force vectors.

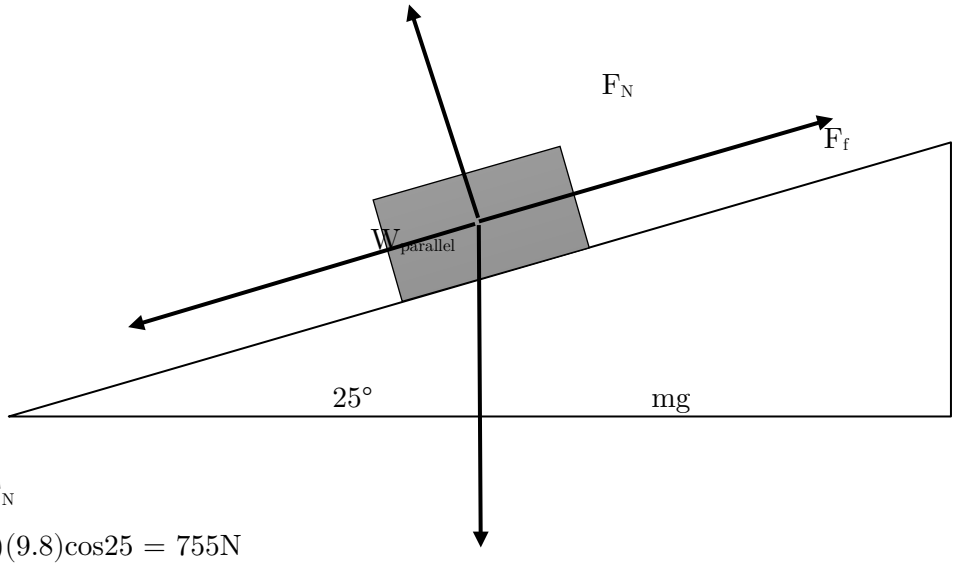


[b] Find the net force on the car.



$\Sigma F = (1000)(9.8)\sin 15 = 2.54 \times 10^3 N$

Q: An 85.0 kg (boy + skateboard) boy is freewheeling on his skateboard down a 25.0^0 slope. If the frictional forces experienced is 10% of the normal force. Determine the net force down the slope.



$F_f = 0.1F_N$

$F_N = (85)(9.8)\cos 25 = 755N$

$F_f = 75.5N$

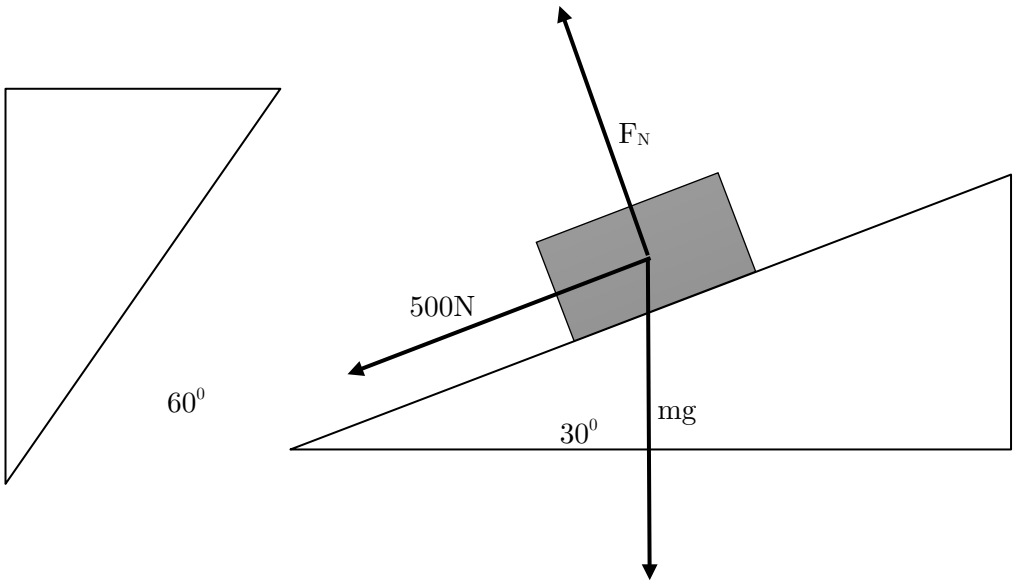
$W_{parallel} = (85)(9.8)\sin 25 = 352N$

$\Sigma F_{slope} = 352 - 75.5 = 277N$ down the slope

Q: If a roller coaster has a mass of 1.00 tonne including passengers, what force will be accelerating it down a track that is 50.0^0 down from the horizontal?

$(1000)(9.8)\sin 50 = 7.51 \times 10^3 N$ down the slope

Q: A roller coaster is rolling down a slope that is 60.0^0 up from the vertical. If the component of gravitational force acting down the slope is 500.0 N, what is the mass of the car?



$$\sin 30 = \frac{500}{mg}$$

$$\text{mg} = \frac{500}{\sin 30} = 1000$$

$$\text{m} = \frac{1000}{9.8} = 1.02 \text{ x } 10^2 \text{kg}$$

Q: An aeroplane flies 400 km in a direction N 40^0 W and then 150 km in a direction of S 35^0 W.

[a] What are the northerly and westerly components of these two displacements?

North_1: 400cos40 = 306km North

North_2: –150cos35 = –123km North

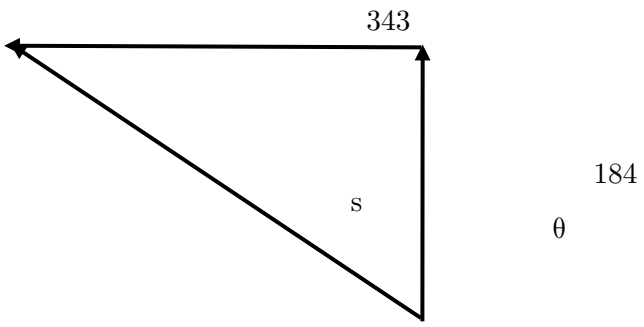
West_1: 400sin40 = 257km West

West_2: 150sin35 = 86.0km West

[b] What is the displacement of the aeroplane from its starting point?

North: 306 – 123 = km North

West: 257 + 86.0 = 343km West



$s = \sqrt{343^2+184^2} = 389\text{km}$

$\theta = \tan^{-1}(\frac{343}{184}) = 61.9°$

$TB = 360 - 61.9 = 298°$

Q: An aeroplane takes off from an aerodrome with an initial velocity of 100 kmh^{-1} at an angle of 15^0 above the horizontal. Find the horizontal and vertical components of the velocity.

$u_v = 100\sin 15 = 25.9 kmh^{-1}$

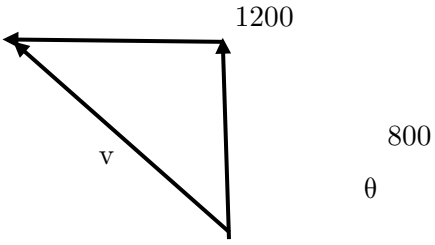
$u_h = 96.6 kmh^{-1}$

Q: A ferry is taking tourists on a sightseeing tour on a lake. It first travels 0.80 km north and then 1.2 km west at a steady speed of 0.5 ms^{-1}.

[a] What is the time taken?

$t = \frac{800+1200}{0.5} = 4.00 \text{ x } 10^3 s$

[b] What is the average velocity?



$s = \sqrt{1200^2+800^2} = 1.44 \text{ x } 10^3 m$

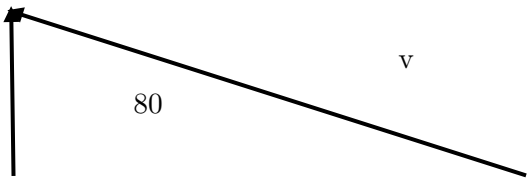
$v - \frac{1.44 x 10^3}{4000} = 0.361 ms^{-1}$

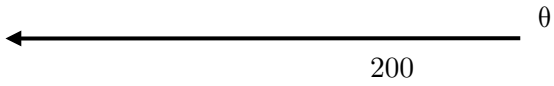
$\theta = \tan^{-1}(\frac{1200}{800}) = 56.3°$

$TB = 360 - 56.3 = 304°$

$v = 0.361 ms^{-1}\ 304°$

Q: A plane is flying due west at 200 kmh^{-1} in a northerly wind of 80 kmh^{-1}. What is the velocity of the plane relative to the ground?



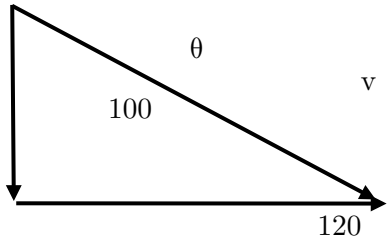


$v = \sqrt{200^2+80^2} = 215 ms^{-1}$

$\theta = \tan^{-1}(\frac{80}{200}) = 21.8°$

$v = 215 ms^{-1}$ 21.8° from the line perpendicular to the direction of the wind

Q: A pilot of a light aircraft intends to fly due east at 120 kmh^{-1} but when she gets into the air a cross wind blowing from the north affects the flight. If the speed of the wind is 100 kmh^{-1}, in what direction and at what speed does the aircraft really travel?



$v = \sqrt{100^2+120^2} = 156 kmh^{-1}$

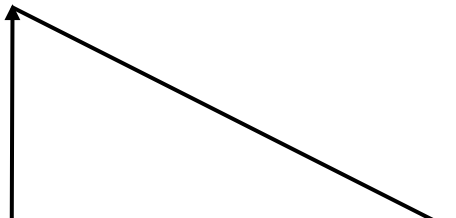
$\theta = \tan^{-1}(\frac{120}{100}) = 50.2°$

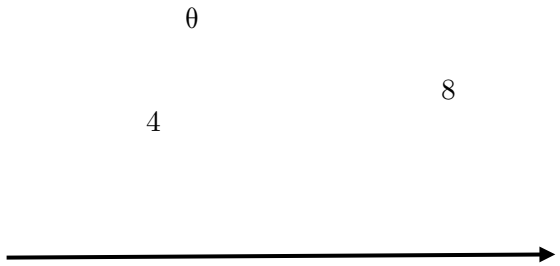
TB = 180 – 50.2 = 130°

$v = 156 kmh^{-1}$ 13.0 x 10°

Q: A ferry captain wishes to travel directly across a river. A current of 4.0 kmh^{-1} is flowing and the ferry can travel at 8.0 kmh^{-1}.

[a] In which direction should the captain direct the ferry?





Direction: $\cos^{-1}(\frac{1}{2}) = 60°$

60° from the direction of the current

[b] What is the resultant velocity of the ferry as seen by someone standing on the bank?

$v = \sqrt{64-16} = 6.93 ms^{-1}$

Q: A car travelling around a round-about changes its velocity from 5.00 ms^{-1} west to 5.00 ms^{-1} east in 3.00 s.

[a] What is the change in velocity?

$\Delta v = v - u = 5 - (-5) = 1.00 \times 10 ms^{-1}$ East

[b] What is the average acceleration?

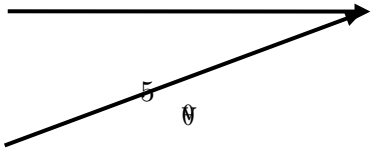
$a = \frac{\Delta v}{t} = \frac{10}{3} = 3.33 ms^{-2}$ East

Q: A cricket ball is hit into the air with an initial velocity of projection of 25 ms^{-1} at an angle of 35^0 above the horizontal. What are the horizontal and vertical components of this initial velocity?

$u_v = 25\sin 35 = 14.3 ms^{-1}$

$u_h = 25\cos 35 = 20.5 ms^{-1}$

Q: A man rows a boat in a northerly direction at 5.0 ms^{-1} across a river. A current is flowing due east at 12 ms^{-1}. What is the actual velocity of the boat relative to the bank of the river?



$v = \sqrt{144+25} = 13.0 ms^{-1}$

$\theta = \tan^{-1}(\frac{12}{5}) = 67.4°$

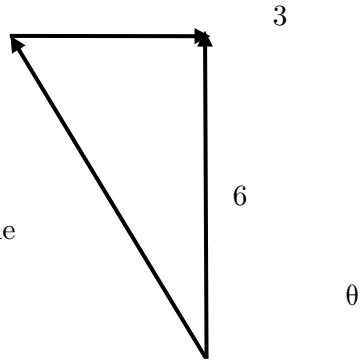
$v = 13.0 ms^{-1}\ 067.4°$

Q: An oarsman wishes to row a boat directly across a river.

[a] If the current flows at 3.0 kmh^{-1} and the oarsman can row at 6.0 kmh^{-1} , in what direction should the boat be headed?

$\theta = \sin^{-1}(\frac{1}{2}) = 30°$

30° from the line perpendicular to the direction of the river



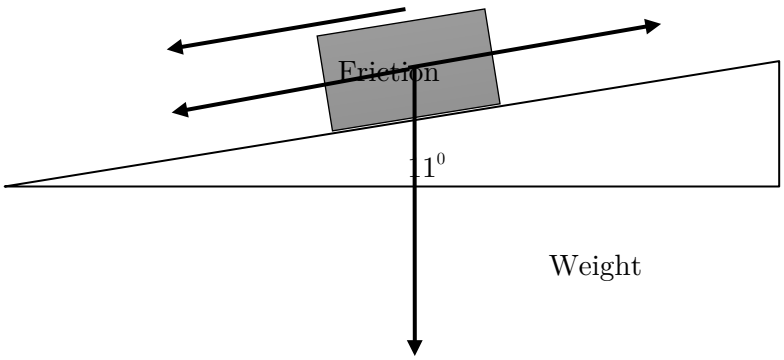
[b] What is the resultant velocity as seen by the oarsman's wife who is standing on the bank of the river?

$v = \sqrt{36+9} = 6.71 kmh^{-1}$

$v = 6.71 ms^{-1}$ directly across the river

Q: A 1500 kg car is travelling up a 11.0^0 slope at a constant speed of 60 km/h. e frictional force is 9 400 N. Determine the driving force applied by the car.

$W_{parallel}$ Driving force



$\Sigma F = -W_{parallel} - F_f + F_d = 0$

$F_d = W_{parallal} + F_f = (1500)(9.8)\sin 11 + 9400 = 1.22 \times 10^4 N$ up the slope