Summary Method M1 (Jun '12)

1.

a)

Construct a vector diagram. The vector triangle will be made up of the speed relative to the water and the speed of the water. Use Pythagoras to find the resultant velocity.

b)

Use right-angled trigonometry to find an angle in your vector triangle, then relate it to the diagram, giving your bearing measured clockwise from north.

2.

Calculate the initial momentum of the two trains, then the final momentum and use conservation of momentum to put these two equal to each other and find the unknown mass.

3.

a)

i.

Use SUVAT equations with the initial speed, final speed and distance to calculate acceleration.

ii.

Use SUVAT equations with a final speed of 0 to calculate time, given the acceleration you found in a)i.

iii.

Use $F = ma$ to calculate the resultant force (which, in this case, is all due to braking). Note that this will be pointing backwards (hence the negative acceleration earlier), but the question asks for the magnitude of the braking force.

b)

Use $F = ma$ again, but this time take into account the additional resistive force when finding the resultant. You should get a smaller braking force, since air resistance will assist in slowing the car down.

4.

a)

Resolve horizontally and rearrange to find θ.

b)

Resolve vertically, using your value of θ from part a), to find W.

c)

Recall that weight is a force which is equal to mg where m is mass and g is acceleration due to gravity.

5.

a)

Deal with the block and the particle separately. Resolving forces for each in the direction of motion and using $F = ma$ will yield two equations in T (the tension) and a (the acceleration). Solve simultaneously, eliminating the tension, to find the acceleration.

b)

i.

Resolve and use $F = ma$ for the hanging particle to find T with this known acceleration.

ii.

Resolve vertically for the block to find the normal reaction.

iii.

Find the frictional force by resolving for the block in the direction of motion and using our value for the tension found in b)i. Then use $F_r = \mu R$, since the block is in motion, to calculate μ.

c)

We have assumed air resistance is negligible, we assume the string attached to the block lies horizontally, and we are modelling the block as a particle.

6.

a)

Your diagram should take into account the normal reaction, which always acts at right angles to the surface, and friction, which always opposes motion.

b)

Resolve vertically, and rearrange to find R in terms of T.

c)

Use $F = ma$ to find the resultant force given the acceleration and the mass, then resolve in the direction of motion to find the resultant force in terms of T. Use this to calculate T.

7.

a)

Use SUVAT equations in two dimensions to find the final velocity (use time $t = t$ for an expression in terms of t), given the acceleration and initial velocity. Note that the particle starts at the origin, so a calculation of change of displacement will give absolute displacement from the origin.

b)

The point which is due east of the origin must have a displacement with a northerly (j) component of 0, and a positive easterly (i) component. Use your expression for position from part b), and solve the resulting equation.

c)

The particle will be travelling south-east when the velocity is $\begin{bmatrix} a \\ -a \end{bmatrix}$ for some positive value of a. Find an expression for the final velocity after t seconds, then put it equal to this, solve to find a, then find the magnitude of this vector using Pythagoras to calculate the speed from the velocity.

8.

a)

Use SUVAT equations to examine the vertical component of motion. Construct an equation involving θ by resolving vertically, and use $t = 2$ and $v = 0$ to find $\sin\theta$.

b)

Use an appropriate SUVAT equation, using your value of $\sin\theta$, to find the vertical displacement at $t = 2$.

c)

Resolve horizontally to find the horizontal component of the velocity, then use $v = \frac{x}{t}$. Note that the time taken to travel from A to B must be twice that to travel from A to C.

d)

Use $s = ut + \frac{1}{2}at^2$ with vertical motion to find the two times at which the vertical displacement is equal to 5, then find the difference between these two times.

e)

The particle is travelling slowest when its vertical velocity (the only one which changes at all) is 0. Its speed at this point will be equal to its horizontal velocity.