Summary Method M2 (Jun '11)

1.

a)

Use the kinetic energy formula $KE = \frac{1}{2}mv^2$.

b)

Conservation of energy means that the total energy (of all types) is the same at any point in the motion. Calculate the energy at the start and the energy at the end and put them equal to each other.

2.

Make a table with the x-coordinate, y-coordinate and mass of each particle, and include a row with x and y and m for the coordinates and mass of the whole. By using the total of the masses to calculate m, find x by multiplying each x-coordinate by the mass, totalling these and making equal to xm. Do the same with y.

3.

a)

Acceleration is the differential of velocity, so find $\frac{dv}{dt}$ separately for the i and j components and put in vector form.

b)

i.

Use $F = ma$ to find force from your expression for acceleration.

ii.

Set $t = 0$ into your expression for F. Then find the magnitude of this vector.

c)

For F to be acting due west, the north component (j) must be zero, and the east component (i) must be negative.

d)

Position (or displacement) is given by the integral of v, so calculate $\int v\, dv$, and use the initial conditions given to find your constant of integration.

4.

a)

The forces acting will be the weight of the man and the weight of the plank (both acting in the middle of the plank), the normal reaction at C and the normal reaction at D. Note: since these are 'forces acting on the plank', they do *not* include the normal reaction force exerted on the man by the plank (just as the equal and opposite reaction forces exerted on the supports by the plank are not included).

b)

Take moments about C (since we do not know the reaction force here). Recall that clockwise and anticlockwise moments will be equal since the plank is not moving.

c)

The uniformity of the plank allows us to assume that its weight will be acting in the centre.

5.

a)

Convert km/h to m/s.

b)

Use the power formula $P = Fv$ to convert the motive force and the maximum speed of the train to power.

6.

a)

Use $F = ma$ to convert force to acceleration. Use the fact that $a = \frac{dv}{dt}$ to form a differential equation.

b)

Solve the differential equation by separating the variables (all the vs on the side with dv, etc). Use the initial condition to find the value of the constant of integration and simplify.

7.

a)

Resolve vertically to find the unknown tension.

b)

Use the speed of the particle and the centripetal force (resultant force towards centre; a combination of the two tensions) to find the radius using the formula $F = \frac{mv^2}{r}$.

8.

a)

To make complete revolutions, the speed at the top of the circle must be positive (note: normal reaction forces are not limiting in the case of a bead on a wire, since they can point in either direction and do not inhibit circular motion). Use conservation of energy to determine the minimum energy required at the top, and therefore the bottom of the circle, and convert to speed using $KE = \frac{1}{2}mv^2$.

b)

i.

Use conservation of energy to determine the energy, and therefore the velocity, when at point B. Use $F = \frac{mv^2}{r}$ to determine the centripetal force for this velocity. Resolve weight and normal reaction to find an expression for the centripetal force, and equate the two results.

ii.

Set $R = 0$ in your equation for part i, and solve for θ.

9.

a)

Use the formula $EPE = \frac{\lambda e^2}{2l}$, being careful to correctly define the extension and natural length, to determine elastic potential energy.

b)

Since energy is conserved, the total energy at the start of the motion is equal to the total energy at the end. Initial kinetic energy is all converted to elastic potential energy.

c)

Taking into account the resistive force, work is done against this resistance, so the total energy at the start will be equal to the work done against friction plus elastic potential energy at the end.