Summary Method M1 (Jan '08)

1.

a)

Use kinematics equations of motion to calculate the acceleration. $s = ut + \frac{1}{2}at^2$.

b)

Use Newton's law: $F = ma$.

c)

Average speed is given by $\frac{Total\ Distance}{Total\ Time}$.

2.

a)

Draw a vector triangle illustrating the velocity of the ship and the velocity of the water, along with the resultant vector giving the resultant velocity. Use Pythagoras to find U.

b)

Use right-angle trigonometry to find the appropriate angle in your vector triangle, then convert to a bearing (3 figures, clockwise, from north). Note: The question requests accuracy to the nearest degree.

3.

a)

Draw a force diagram. Weight will be acting vertically down from the particle, and different tensions will be acting away from the particle in the strings.

b)

Resolve vertically, using the fact that the particle is in equilibrium.

c)

Resolve horizontally, using your value from part b), and the fact that the particle is in equilibrium.

4.

a)

i.

Generate simultaneous equations by using the conservation of momentum formula:
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$. Solve for U.

ii.

Substitute to find V.

b)

Using your value for U, apply Pythagoras' Theorem to find the magnitude of velocity, ie speed.

5.

a)

i.

Draw a force diagram, and resolve forces parallel to the slope. Use $F = ma$ to determine acceleration.

ii.

Use kinematic equations of motion to determine the distance s for the puck to reach a final velocity $v = 0$ given the initial velocity $u = 4$ and constant acceleration as calculated in i.

iii.

Since the acceleration is constant due to forces remaining the same, the puck will immediately start to move down the slope.

b)

i.

Resolve perpendicular to the slope to find the normal reaction, then apply $F_r = \mu R$.

ii.

Resolve parallel to the slope and apply $F = ma$.

iii.

Since in this case the forces acting on the puck are not the same when at rest as when in motion, you need to calculate the resultant force down the slope (the slope-parallel component of weight) to determine if it is greater than the maximum frictional force (now directed up the slope). If it is greater, the puck will accelerate down the slope, but more slowly than it decelerated up the slope. If it is lower, the puck will remain at rest.

6.

a)

Draw a force diagram, including tension in the tow bar acting away from the tractor on the right hand side and away from the skip on the right. Resolve vertically to find the normal reaction for the skip. Use the coefficient of friction in $F_r = \mu R$ to find the magnitude of the frictional force.

b)

Resolve horizontally, for the entire system combined ($P - F_r$), using Newton's law: $F = ma$ to determine the driving force.

c)

Resolve separately for either the skip or the tractor, again using Newton's law, to calculate T.

d)

Note that the angle of the towrope would affect your original answer, since the normal reaction of the skip would be lower due to the vertical component of tension. This in turn reduces friction.