

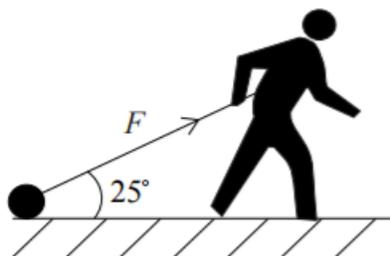
Hovercraft 2017-2018

Names: _____

Score: _____ / 44

Show all equations and work. Point values are shown in parentheses at the end of the question. Assume $g=9.8 \text{ m/s/s}$ for all calculations. Include units in your answer.

1. An athlete trains by dragging a heavy load across a rough horizontal surface.



The athlete exerts a force of magnitude F on the load at an angle of 25° to the horizontal.

- a) Once the load is moving at a steady speed, the average horizontal frictional force acting on the load is 470 N. What is the average value of F that will enable the load to move at constant speed? (1)

- b) The load is moved a horizontal distance of 2.5km in 1.2 hours. Calculate:

i. The work done on the load by the force F (2)

ii. The minimum average power required to move the load (2)

2. A cylinder has a radius of 0.920 cm and is 25.0 cm long. How far will it sink into a mixture with a density of 865 kg/m^3 if the cylinder has a mass of 37.5 grams, assuming it is weighted so it floats vertically? (5)

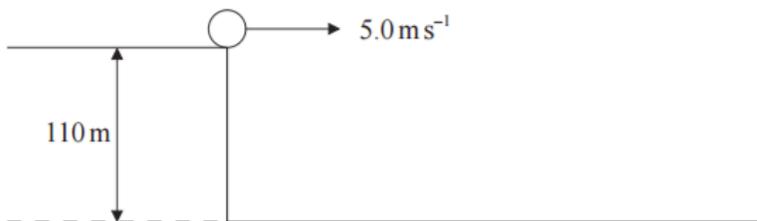
3. A railway engine is travelling along a horizontal track at a constant velocity.

a) Explain, with reference to Newton's laws of motion, why the velocity of the railway engine is constant. (2)

b) The power driving the railway engine is switched off. A total horizontal resistive force of 76 kN acts on the railway engine. The railway engine stops, from its speed of 16 m/s, without braking, in a distance of 1.1km. A student hypothesizes that the horizontal resistive force is constant.

Based on this hypothesis, calculate the mass of the railway engine. (2)

4. A ball is projected horizontally at 5.0 m/s from a vertical cliff of height 110m . Assume that air resistance is negligible and $g = 10\text{m/s/s}$.



a) What is the magnitude of the horizontal component of acceleration of the ball after it leaves the cliff? (1)

b) What is the time taken for the ball to reach the ground? (2)

c) What is the horizontal distance travelled by the ball when it reaches the ground? (2)

5. A railway truck on a level, straight track is initially at rest. The truck is given a quick, horizontal push by an engine so that it now rolls along the track.

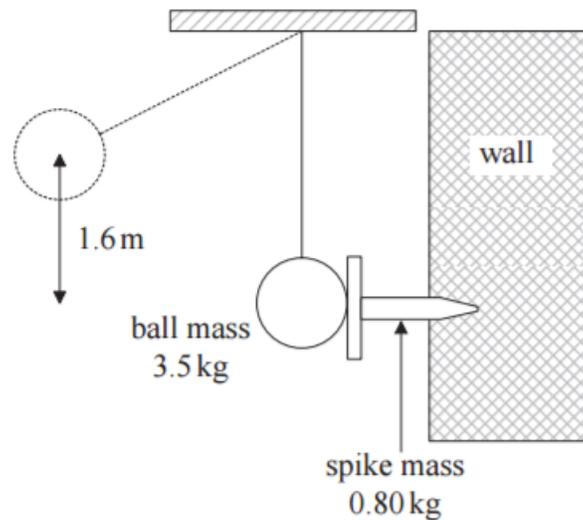
The initial speed of the truck after the push is 4.3 m/s . The mass of the truck is $2.2 \times 10^3 \text{ kg}$.

a) After contact with the engine, the truck moves a distance 15m along the track. After travelling this distance the speed of the truck is 2.8m/s . Assuming a uniform acceleration, calculate the time it takes the truck to travel 15m . (2)

b) What is the average rate at which the kinetic energy of the truck is dissipated as it moves along the track? (2)

c) When the speed of the truck is 2.8 m/s it collides with a stationary truck of mass 3×10^3 kg. The two trucks move off together with a speed V . What is the speed V ? (2)

6. A large swinging ball is used to drive a horizontal iron spike into a vertical wall. The center of the ball falls through a vertical height of 1.6m before striking the spike in the position shown.



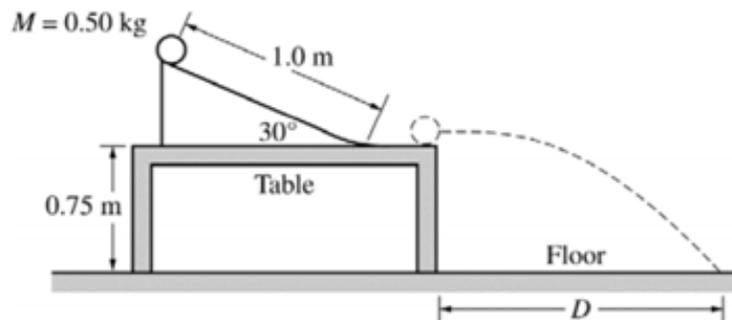
The mass of the ball is 3.5 kg and the mass of the spike is 0.80kg. Immediately after striking the spike, the ball and spike move together.

a) What is the speed of the ball on striking the spike? (2)

b) What is the energy dissipated as a result of the collision? (4)

7. A hydraulic jack has an input piston diameter of 0.85cm and an output piston diameter of 4.50cm. What force must you exert on the input piston to lift a 1210kg car? (2)

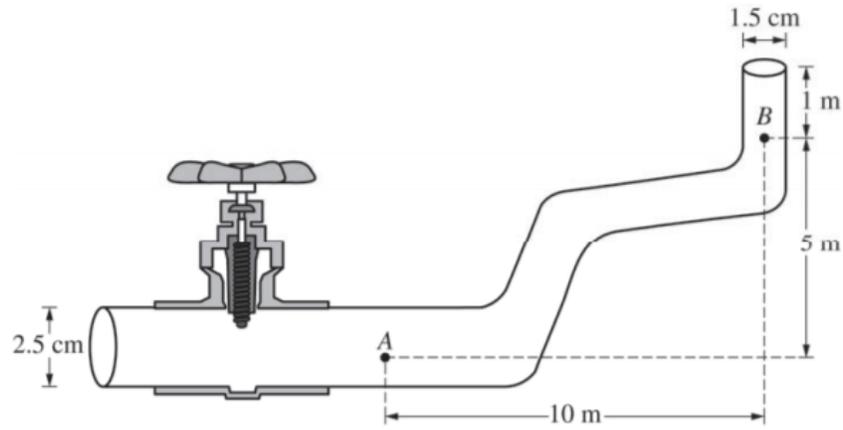
8. A uniform solid block of mass $M=0.50$ kg is released from rest, slides down a 1.0m long inclined plane, and is launched horizontally from a horizontal table of height 0.75m. The inclined plane makes an angle of 30° with the horizontal. The block lands on the floor a distance D away from the edge of the table. There is a smooth transition from the inclined plane to the horizontal table, and the motion occurs with no frictional energy losses.



a) What is the kinetic energy of the block as it reaches the horizontal table? (2)

b) What is the horizontal distance D ? (3)

9. Water flows left to right through the section of pipe shown below, which decreases in diameter and increases in elevation. The pipe ends on the right, where the water exits vertically. At point A the water is known to have a speed of 0.50 m/s and a pressure of $2.0 \times 10^5 \text{ Pa}$. The density of water is 1000 kg/m^3 .



a) What is the speed of the water at point B? (2)

b) The water pressure at point B compared to point A is: (1)

Greater than at point A

Equal to point A

Less than at point A

Justify your answer. (2)

c) What is the pressure in the pipe at point B? (1)