

Fundamental Mechanics: Class Exam 3

11 November 2022

Name: _____

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Instructions

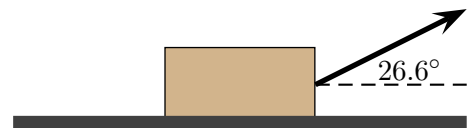
- There are 8 questions on 6 pages.
- Show your reasoning and calculations and always explain your answers.

Physical constants and useful formulae

$$g = 9.81 \text{ m/s}^2$$

Question 1

A crate is dragged along a rough horizontal surface by a rope and moves 4.00 m during a certain period of observation. The rope exerts a 100 N force along the illustrated direction.

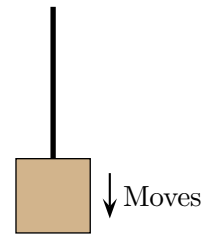


- Determine the work done by the rope during the period of observation.
- During the period of observation, the cart moves with constant speed. Determine the work done the kinetic friction force.

Question 2

A crate is suspended by a rope and is lowered vertically. While this happens, which of the following (choose one) is true about the work done by the rope, W ?

- i) $W > 0$ if the crate speeds up and $W < 0$ if it slows down.
- ii) $W < 0$ if the crate speeds up and $W > 0$ if it slows down.
- iii) $W > 0$ regardless of the speed.
- iv) $W < 0$ regardless of the speed.

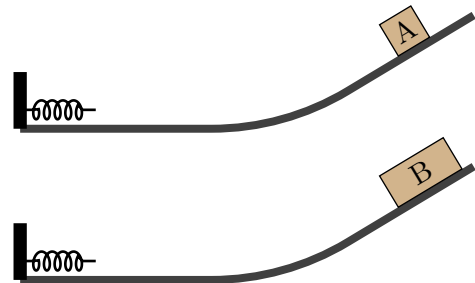


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Question 3

Two boxes are released from rest at the same height on identical frictionless surfaces. The mass of box B is four times that of box A. They collide with and compress identical springs. Which of the following (choose one) is true regarding the maximum compression of each spring (Δx_A for that with box A, Δx_B for that with box B)?

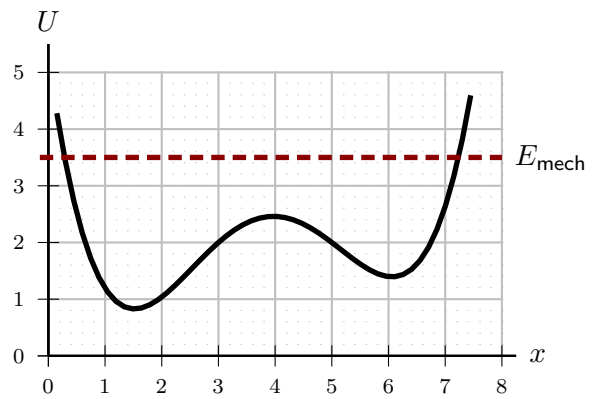
- i) $\Delta x_B = 4\Delta x_A$.
- ii) $\Delta x_B = 2\Delta x_A$.
- iii) $\Delta x_B = \Delta x_A$.
- iv) $\Delta x_B = \frac{1}{2} \Delta x_A$.
- v) $\Delta x_B = \frac{1}{4} \Delta x_A$.



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Question 5

A particle with the illustrated total mechanical energy moves subject to the illustrated potential. Indicate all locations where the **speed is a maximum** and **the force on the particle is zero**. Explain your answer.



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Question 6

A particle can move horizontally along the x axis. The potential energy of the particle is $U = ax^2 + bx^4$ where $a = -6.0 \text{ J/m}^2$ and $b = 3.0 \text{ J/m}^4$. Determine the force on the particle, including direction, at $x = 2.0 \text{ m}$.

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Question 8

Two ice skaters, Alice with mass 60 kg and Bob with mass 90 kg, slide toward each other on a sheet of ice. Alice moves right with speed 10 m/s and Bob moves left with speed 5.0 m/s. They collide and Bob subsequently moves right with speed 1.5 m/s. Ignore friction and air resistance.

a) Determine Alice's speed after the collision.

b) Explain whether the total mechanical energy defined as $E = K + U_{\text{grav}}$ is conserved in this collision.

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