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Name:

Algebra Based Physics  
Forces and Newton's Laws test (P)

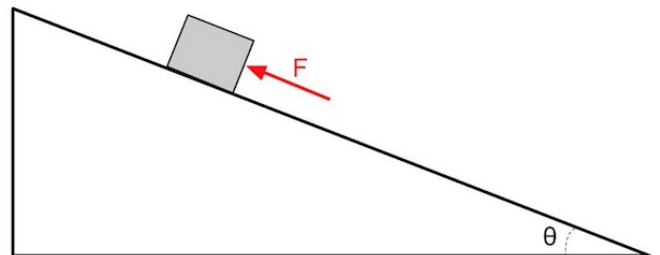
You must always show all work and include the correct sign and correct units for all answers. Assume + is up or right.

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1. Explain what Newton's first Law says, and give an example that demonstrates Newton's first law.
2. Explain what Newton's second Law says, and give an example that demonstrates Newton's second law.
3. Explain what Newton's third Law says, and give an example that demonstrates Newton's third law.

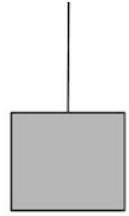
4. A box of mass  $m$  is being allowed to slide down an incline at an angle  $\theta$  at a constant speed. The coefficient of kinetic friction between the box and the incline is  $\mu_k$ . What is the magnitude of the force  $F$  required in order to allow the mass to slide down the incline at constant speed?

- (A)  $F = mg\sin\theta + \mu_k mg\cos\theta$
- (B)  $F = mg\sin\theta - \mu_k mg\cos\theta$
- (C)  $F = mg\sin\theta$
- (D)  $F = \mu_k mg\cos\theta$

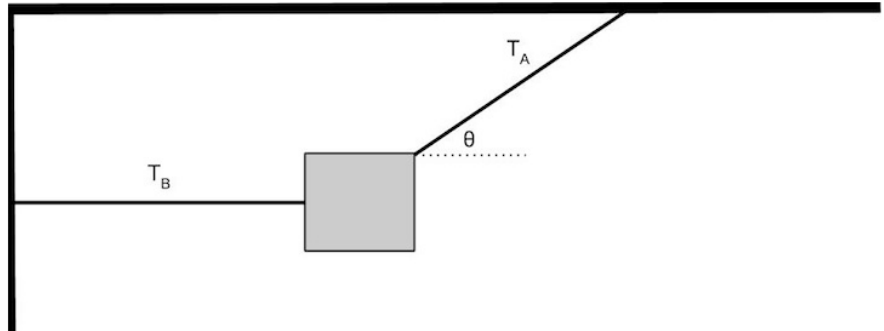


5. A 3kg mass is being pulled upwards by a string with a constant velocity of +4m/s. How does the tension in the string compare to the weight of the 3kg mass?

- (A) The tension in the string is smaller than the weight of the 3kg mass
- (B) The tension in the string is equal to the weight of the 3kg mass
- (C) The tension in the string is greater than the weight of the 3kg mass
- (D) The tension in the string is zero



The diagram to the right is for questions 6-7:  
A box is hanging from two strings. String A is directed at an angle of  $\theta=30^\circ$  from horizontal as seen to the right. The tension in string A is  $T_A = 100\text{N}$ .



6. What is the tension in string B ( $T_B$ )?

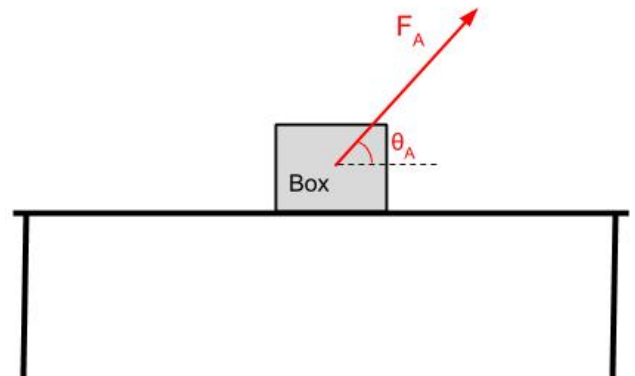
- (A) 50 N
- (B) 86.6 N
- (C) 100 N
- (D) 115.5 N

7. What is the mass of the box hanging from the strings?

- (A) 5.1kg
- (B) 9.8kg
- (C) 10.2kg
- (D) 50kg

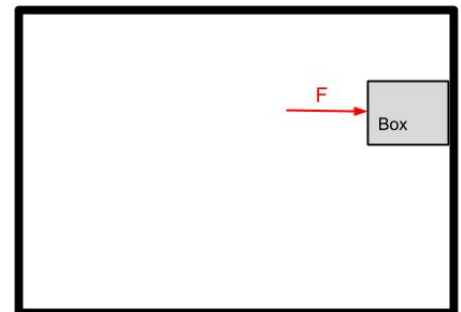
8. A box of mass  $m$  has a force  $F_A$  exerted on it at an angle  $\theta_A$  as shown to the right. This causes the box to slide across the rough table. The coefficient of kinetic friction between the box and the table is  $\mu_k$ . What is the magnitude of the force of kinetic friction on the box?

- (A)  $\mu_k mg$
- (B)  $\mu_k (mg - F_A \cos \theta_A)$
- (C)  $\mu_k (mg + F_A \sin \theta_A)$
- (D)  $\mu_k (mg - F_A \sin \theta_A)$

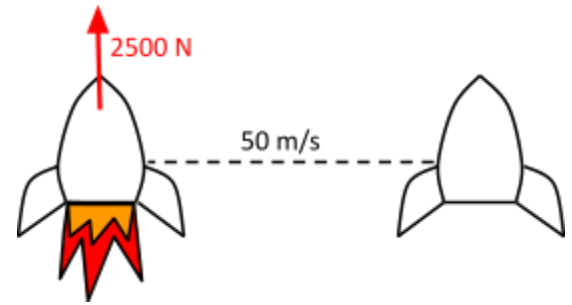


9. A box of mass  $m$  is pushed into a vertical wall with a force  $F$ . The coefficient of static friction between the box and the wall is  $\mu_s$ . What is the minimum force  $F$  required in order to prevent the box from slipping?

- (A)  $\mu_s mg$
- (B)  $mg/\mu_s$
- (C)  $\mu_s/(mg)$
- (D)  $mg$



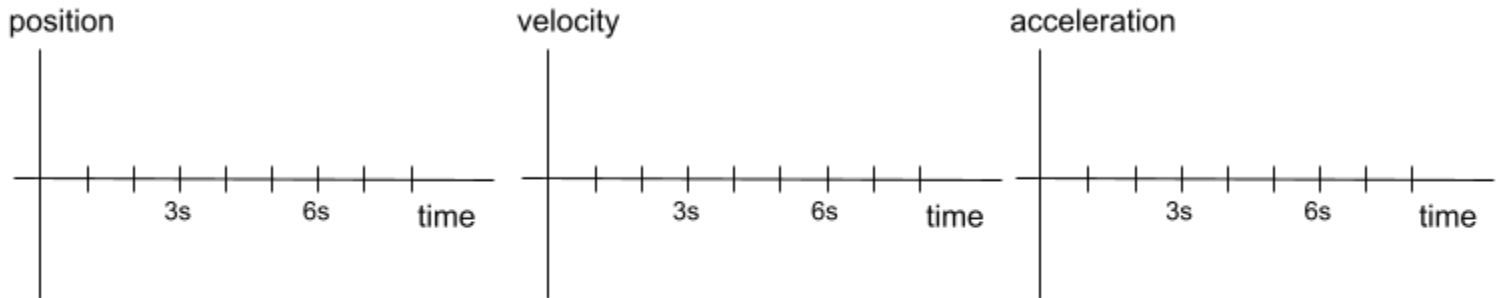
10. At time  $t=0$  seconds a 100kg space rocket is drifting to the left in deep empty space (with no forces on it) with constant speed of 50m/s. At  $t=3$  seconds the rocket thruster fires which exerts a force of 2,500N straight upwards in the vertical direction on the rocket. The thruster continues firing until time  $t=6$  seconds, after which the thruster turns off and the rocket again has no forces acting on it.



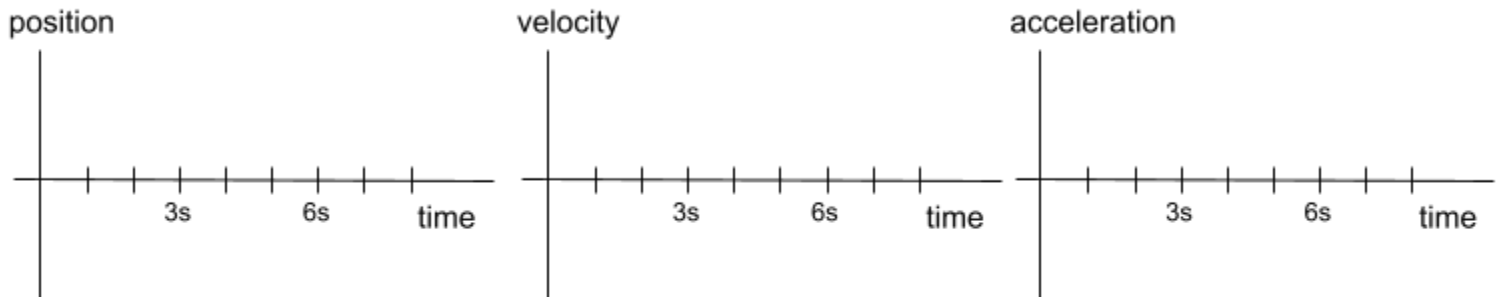
a. What will be the total speed of the rocket at time  $t=7$  seconds?

b. What will be the angle of the total velocity of the rocket (as measured counterclockwise from the positive x axis) at  $t=7$  seconds?

c. Graph the horizontal position, horizontal velocity, and horizontal acceleration of the rocket from time  $t=0$  until time  $t=8$  seconds. (Assume the horizontal position of the rocket is zero at  $t=0$ )

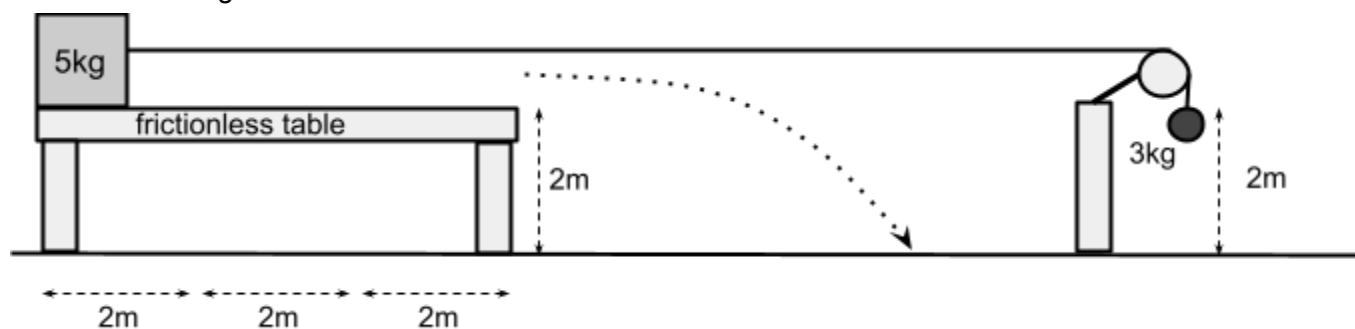


d. Graph the vertical position, vertical velocity, and vertical acceleration of the rocket from time  $t=0$  until time  $t=8$  seconds. (Assume the vertical position of the rocket is zero at  $t=0$ )



e. Describe the motion of the rocket between  $t=8$  seconds and  $t=10$  seconds (after the thruster has turned off).

11. A 5kg box on a frictionless table is connected to another hanging 3kg black spherical mass via a massless string and a frictionless pulley as seen below. Both masses are released from rest and the 3kg mass pulls the 5kg mass to the right causing it to fly off the edge of the table. After the 3kg mass hits the floor the string goes slack and no longer exerts a force on either mass.



a. While the 3kg sphere is moving downwards, is the tension in the string greater than  $(3\text{kg} \times 9.8\text{m/s}^2)$ , less than  $(3\text{kg} \times 9.8\text{m/s}^2)$ , or equal to  $(3\text{kg} \times 9.8\text{m/s}^2)$ ? Explain.

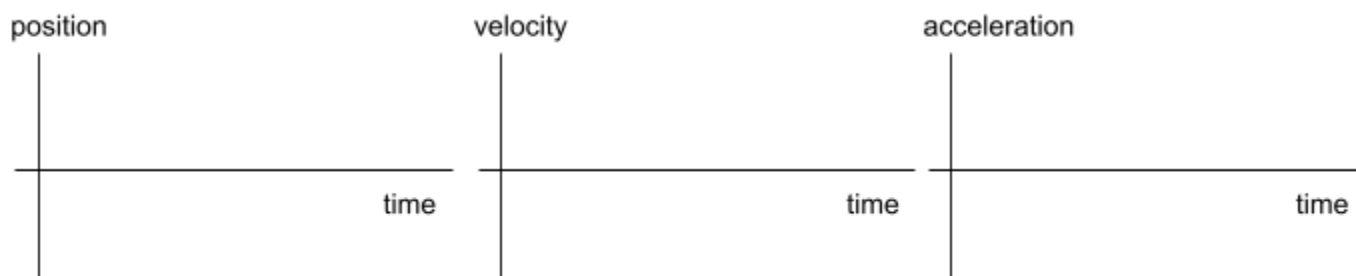
b. What is the acceleration of the 3kg sphere as it moves downwards?

c. How long does it take the 5kg box to travel the first 2m across the table?

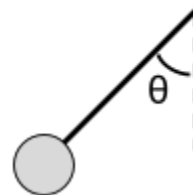
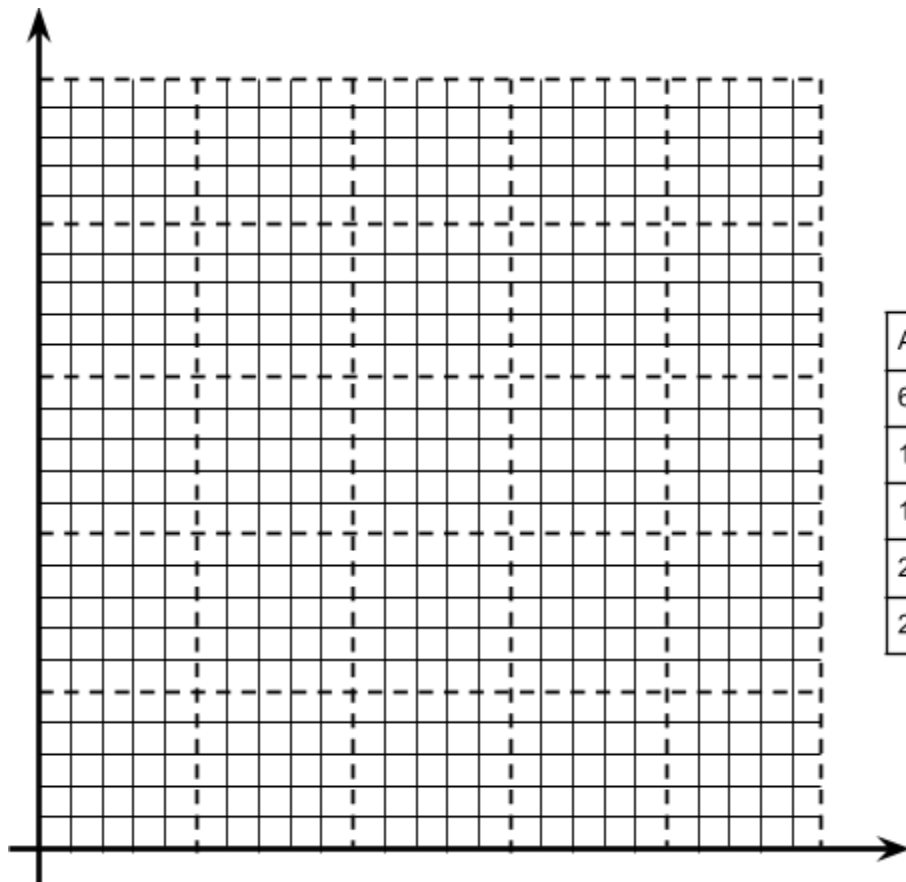
d. What is the speed of the 5kg box when it reaches the end of the table?

e. How far from the edge of the table does the box fly before it hits the ground?

f. Graph the horizontal position, velocity, and acceleration of the 5kg box from the moment it is released until it hits the floor. You do not need to label the axes. (Assume the horizontal position of the box is zero at  $t=0\text{s}$ )



12. A student rides on a train moving with different accelerations. She allows a mass  $M$  to hang from a string and measures the different angles for each acceleration in the data table shown below.



| Angle $\theta$ | Acceleration $a$  |
|----------------|-------------------|
| $6^\circ$      | $1 \text{ m/s}^2$ |
| $12^\circ$     | $2 \text{ m/s}^2$ |
| $17^\circ$     | $3 \text{ m/s}^2$ |
| $22^\circ$     | $4 \text{ m/s}^2$ |
| $27^\circ$     | $5 \text{ m/s}^2$ |

- What equation relates the data?
- What could you plot on the vertical and horizontal axes to get a linear fit? Label the axes appropriately.

$$(y) = (m)(x) + (b) \quad (\text{ }) = (\text{ }) (\text{ }) + (\text{ })$$

- Plot the data and draw a best fit straight line.

- Pick two points on your best fit line and find the slope slope = \_\_\_\_\_

- Use the value of your slope to find an experimental value for the acceleration due to gravity.