
Name: _____ Section: _____ Score: _____/20

1. Sirius is 11 lightyears away from us. How many years does it take a spaceship with a speed 75,000 miles/h to reach Sirius from the earth? 1 lightyear = 9.5×10^{12} km, and 1 mile = 1.6 km. If the answer is x years, we have

$$x \text{ year} = \frac{11 \text{ lightyear}}{75,000 \text{ mile/h}}.$$

Use this formula to obtain x . [5]

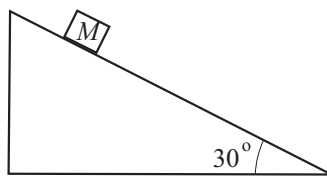
2. Solving the following simultaneous equation, find f . [5]:

$$360 = f \frac{350}{350 + v}, \tag{1}$$

$$430 = f \frac{350}{350 - v}. \tag{2}$$

(3 on the next page)

3. A block of mass M is at rest on an inclined plane as illustrated below. There is a friction between the block and the inclined plane.



(a) Draw a free-body diagram showing all the forces on the block. [5]

(b) Can the coefficient μ of static friction be smaller than 0.6? You must give a brief justification of your answer. [5]

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1. A hybrid car can cover 38 km with one ℓ (liter) of gas. How much does it cost to go from Urbana to Chicago that is 120 miles away? Assume that the gas price is \$3/gallon. 1 gallon = 3.785 ℓ . If we write the answer to be x dollars, we have

$$x \text{ dollar} = \frac{120 \text{ mile}}{38 \text{ km}/\ell} \times 3 \text{ dollar/gallon}.$$

Compute x , using this relation.

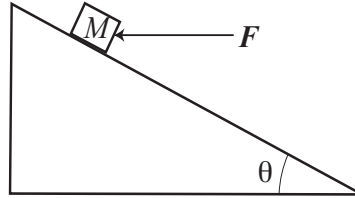
2. Solving the following simultaneous equations, find c :

$$480 = f \frac{c}{c+30}, \tag{1}$$

$$520 = f \frac{c}{c-30}. \tag{2}$$

(3 on the next page)

3. On a frictionless inclined plane making an angle θ with the horizontal direction is a block of mass M , on which a horizontal force \mathbf{F} is acting as shown in the figure. The block is stationary.



(a) Draw a free-body diagram, showing all the forces acting on the block. [5]

(b) Write down the magnitude of the force \mathbf{F} in terms of M , g and θ . [5]

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1. A snail can cover 13 inches in 2 minutes. With this speed how many years does it take the snail to go from Urbana to Chicago that is 120 miles away? Use 1 mile = 1.6 km and 1 inch = 2.54 cm. If we write the answer as x years, then we have

$$x \text{ year} = \frac{120 \text{ mile}}{13 \text{ inch}/2 \text{ min}}.$$

Use this to answer the question. [5]

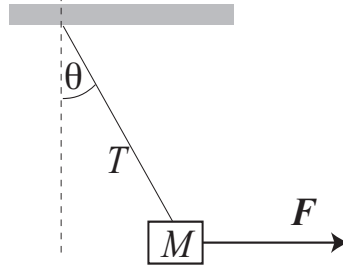
2. Solving the following simultaneous equations, find the ratio v/c : [5]

$$480 = f \frac{c}{c+v}, \tag{1}$$

$$520 = f \frac{c}{c-v}. \tag{2}$$

(3 on the next page)

3. A block of mass M hangs from the ceiling with a massless flexible string. A horizontal force \mathbf{F} is applied on the block, and the string makes a certain angle θ with the vertical direction (denoted by the dotted line) as illustrated below:



(a) Draw a free-body diagram showing all the forces on the block. [5]

(b) Find the magnitude of the tension T in the string in terms of the magnitude of the force F , M , and g . [5]

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1. A molecular motor can move along a microtubule fiber at a speed of 75 nm/s (1 nm = 10^{-9} m). How many minutes does it take the motor to traverse a cell of diameter 12 micrometers ($1\ \mu\text{m} = 10^{-6}$ m)? If we write the answer as x hours, then we have

$$x\ \text{min} = \frac{12\ \mu\text{m}}{75\ \text{nm/s}}.$$

Using this relation, obtain x . [5]

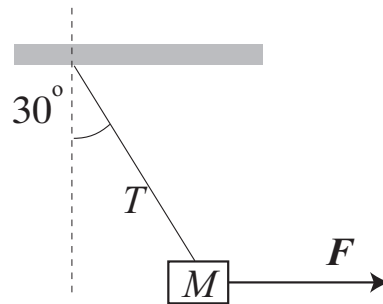
2. Solving the following simultaneous equations, find f : [5]

$$480 = f \frac{c+30}{c}, \tag{1}$$

$$430 = f \frac{c-30}{c}. \tag{2}$$

(3 on the next page)

3. A block of mass M hangs from the ceiling with a massless flexible string. When a horizontal force \mathbf{F} is applied as illustrated in the following figure, the string makes an angle 30° with the vertical direction.



(a) Draw a free-body diagram showing all the forces acting on the block. [5]

(b) Find the magnitude of the tension T in the string in terms of the magnitude of the force F . [5]