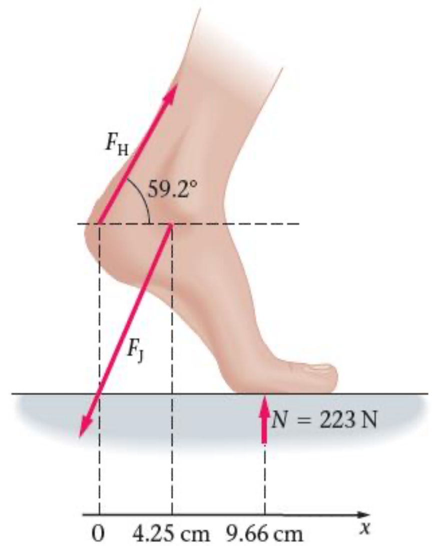
47. ***

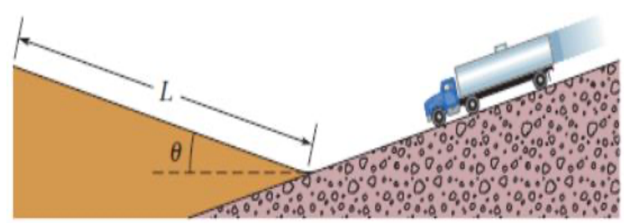
Three forces act on the foot as shown. F_H is the force exerted by the Achilles tendon on the heel. F_J is the force exerted by the ankle joint on the foot. N is the force exerted by the ground on the toes. The foot is in a complete static equilibrium at the moment of consideration. The magnitude of F_J (in terms of the magnitude of the force N) is:



2.39 * N   0.76 * N   1.07 * N   3.11 * N   2.80 * N

48. *

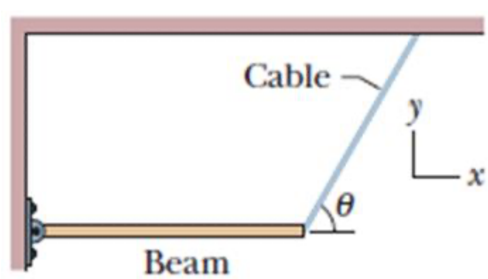
The speed of the truck just before it goes up a frictionless hill (θ = 15°) is 130 km/h. The truck's mass is 1.2 x 10^4 kg. The minimum length along the hill, L (in m), needed so that the truck will momentarily stop is:



256.8   1800.8   66.5   13.3   1048.7

49 & 50. **

The figure belongs to problems 49 & 50



The 53-kg uniform beam shown is 5.0 m long and is supported in a horizontal position by a hinge and a cable. The beam is in a complete static equilibrium when the angle θ is 60°.

49. As a result, the x-component force (in N) exerted by the hinge on the beam is:

-260   +520   -150   +150   +260

50. As a result, the y-component force (in N) exerted by the hinge on the beam is:

-150   +520   +150   +260   -260

51. *

A 0.15 kg ball is thrown vertically upward from the top of a 10-m high building with an initial speed of 12 m/s. At its highest point, the net force (in N) on the ball is:
(Take g = 10 m/s^2)

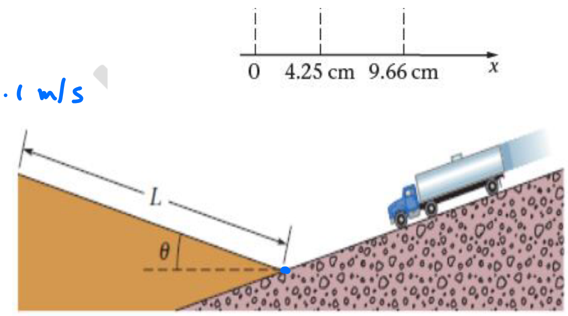
9.8, vertically up   9.8, vertically down   zero   1.5, vertically down   1.5, vertically up

48. *

The speed of the truck just before it goes up a frictionless hill (θ = 15°) is 130 km/h. The truck's mass is 1.2 x 10^4 kg. The minimum length along the hill, L (in m), needed so that the truck will momentarily stop is:

256.8   1800.8   66.5   13.3   1048.7

36.1 m/s



$W_{nc} = \Delta K + \Delta U \rightarrow 0 = \frac{1}{2} m (0 - v_i^2) + mgh$

$\sin(15) = \frac{h}{L}$

$\frac{1}{2} \times 1.2 \times 10^4 \times 36.1^2 = 1.2 \times 10^4 \times 9.8 \times \sin(15) \times L$

$\therefore L = 256.8$

49 & 50. **

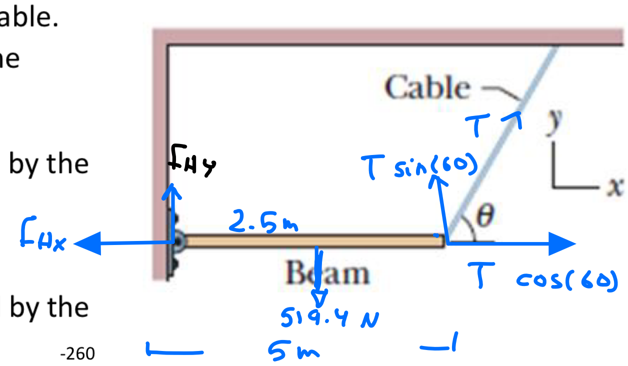
The figure belongs to problems 49 & 50

The 53-kg uniform beam shown is 5.0 m long and is supported in a horizontal position by a hinge and a cable. The beam is in a complete static equilibrium when the angle θ is 60°.

49. As a result, the x-component force (in N) exerted by the hinge on the beam is:

-260   +520   -150   +150   +260

50. As a result, the y-component force (in N) exerted by the hinge on the beam is: -150   +520   +150   +260   -260



49) $\sum \tau = 0$ about hinge point

$-519.4 \times 2.5 + T \times 5 \times \sin(60)$

$T = 299.9$ N

$\sum F_x = 0$

$F_{Hx} = T\cos(60)$

$\therefore F_{Hx} = 149.9$

$F_{Hx} = -150$

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50) $F_{Hy} + T\sin(60) = 519.4$

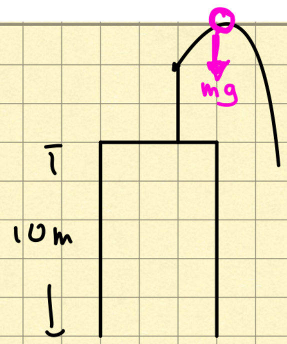
$F_{Hy} = 259.7$

51. *

A 0.15 kg ball is thrown vertically upward from the top of a 10-m high building with an initial speed of 12 m/s. At its highest point, the net force (in N) on the ball is:
(Take $g = 10\ m/s^2$)

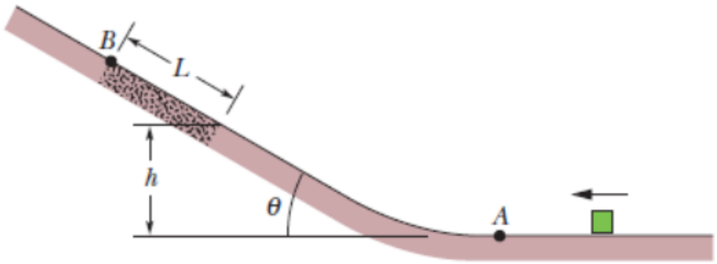
9.8, vertically up 9.8, vertically down zero 1.5, vertically down 1.5, vertically up

$m * g = 0.15 * 9.8 = 1.47$
down



52. ***

As shown, a block passes through point A with a speed of 8.0 m/s heading uphill of angle θ = 30° towards point B. The track AB is frictionless except the rough portion L = 0.75 m, which begins at height h = 2.0 m. In this rough portion, the coefficient of kinetic friction is 0.40.



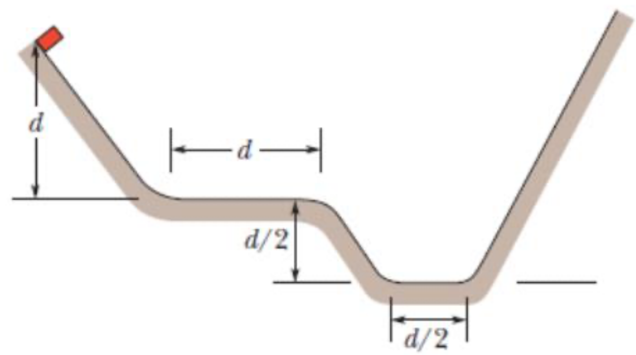
If the block can reach point B (where the friction ends), what is its speed (in m/s) there?

3.52 zero 0.37 4.98

The kinetic energy of the block will turn entirely into potential energy and thermal energy before reaching point B.

53. ***

As shown, a 2-kg block slides from rest down a frictionless hill at height d = 40 cm. It then moves along a horizontal rough level of length d, where the coefficient of kinetic friction is 0.50. If the block is still moving, it then slides down a second frictionless hill at height d/2 and onto a second horizontal rough level, which has length d/2 and where the coefficient of kinetic friction is again 0.50. If the block is still moving, it then slides up a frictionless incline until it momentarily stops. If the block can reach the incline, what is its maximum height (in cm) on the incline measured from the second horizontal level?

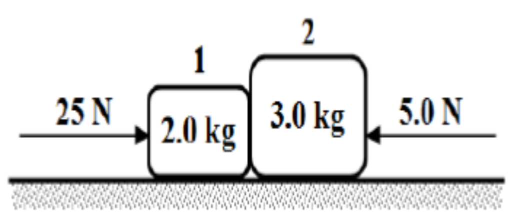


50 30 10 20

The kinetic energy of the block will be dissipated entirely into thermal energy along the second horizontal rough level before start sliding up the incline.

54. **

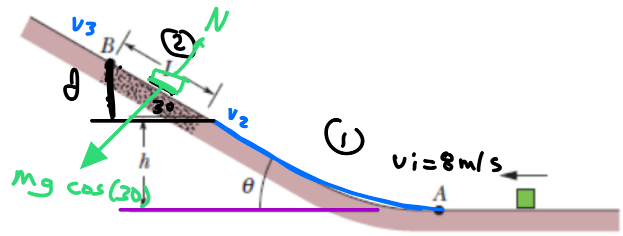
Two blocks of masses 2.0 kg and 3.0 kg move on a horizontal frictionless surface and are subject to two horizontal forces of magnitudes 25 N and 5.0 N, as shown. What is the magnitude of the force (in N) exerted by block 2 on block 1?



37 11 29 21 17

52. ***

As shown, a block passes through point A with a speed of 8.0 m/s heading uphill of angle θ = 30° towards point B. The track AB is frictionless except the rough portion L = 0.75 m, which begins at height h = 2.0 m. In this rough portion, the coefficient of kinetic friction is 0.40.



If the block can reach point B (where the friction ends), what is its speed (in m/s) there?

3.52 zero 0.37 4.98

The kinetic energy of the block will turn entirely into potential energy and thermal energy before reaching point B.

$W_{nc_1} = \Delta K + \Delta U \longrightarrow \frac{1}{2}m(v_2^2 - 64) = -mgh$

$v_2 = 4.98$ m/s

$W_{nc_2} = \Delta K + \Delta U$

$-f_k N * L = \frac{1}{2}m(v_3^2 - v_2^2) + mgd$

$-\mu_k (mg\cos(30)) * L = \frac{1}{2}m(v_3^2 - v_2^2) + mg * L\sin(30)$

$N = mg\cos(30)$

$\sin(30) = \frac{d}{L} \quad \therefore d = L * \sin(30)$

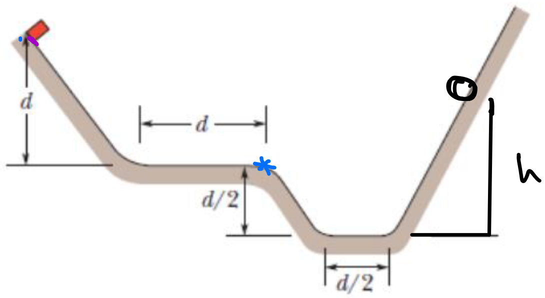
$-0.4 * 9.8 * \cos(30) * 0.75 = \frac{1}{2}(v_3^2 - 4.98^2) + 9.8 * 0.75 * \sin(30)$

$-6.22 = \frac{1}{2}(v_3^2 - 4.98^2)$

$-12.44 = v_3^2 - 4.98^2$

$v_3^2 = 12.4 \quad \therefore v_3 = 3.52$

53. ***



As shown, a 2-kg block slides from rest down a frictionless hill at height d = 40 cm. It then moves along a horizontal rough level of length d, where the coefficient of kinetic friction is 0.50. If the block is still moving, it then slides down a second frictionless hill at height d/2 and onto a second horizontal rough level, which has length d/2 and where the coefficient of kinetic friction is again 0.50. If the block is still moving, it then slides up a frictionless incline until it momentarily stops. If the block can reach the incline, what is its maximum height (in cm) on the incline measured from the second horizontal level?

50 30 10 20

The kinetic energy of the block will be dissipated entirely into thermal energy along the second horizontal rough level before start sliding up the incline.

$W_{nc} = \Delta K + \Delta U$

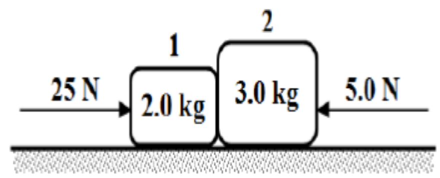
$-f_k d - f_k \cdot \frac{1}{2} d = mg(h - \frac{3}{2} d)$

$-\frac{3}{2} \cdot \mu_k \cdot mg \cdot d = mg(h - \frac{3}{2} d)$

$-\frac{3}{2} \cdot \frac{1}{2} \cdot 0.4 = h - \frac{3}{2} \cdot 0.4$

$-0.3 = h - 0.6 \rightarrow h = 0.3\ m \rightarrow h = 30\ cm$

54. **



Two blocks of masses 2.0 kg and 3.0 kg move on a horizontal frictionless surface and are subject to two horizontal forces of magnitudes 25 N and 5.0 N, as shown. What is the magnitude of the force (in N) exerted by block 2 on block 1?

F_{21}

37 11 29 21 17

considered it one system

$25 - 5 = 5a \rightarrow \therefore a = 4\ m/s^2$

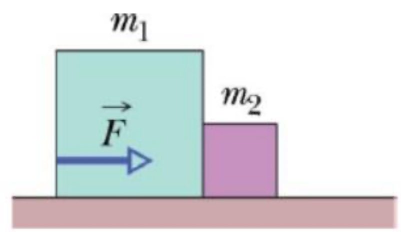
$25 - F_{21} = m_1 \cdot a$

$F_{21} = 25 - 2 \cdot 4$

$= 17$

55. **

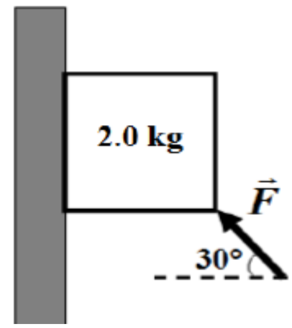
Two blocks, with m_1 = 2.5 kg and m_2 = 1.5 kg, are in contact on a horizontal frictionless table. A horizontal force F is applied to the larger block, as shown. If the magnitude of the force between the two blocks is 1.2 N, what is the magnitude of the applied force F (in N)?



2.0 3.2 2.4 1.2 5.6

56. **

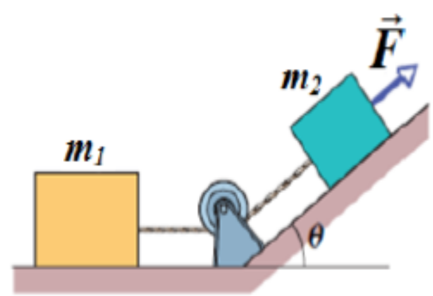
The 2.0 kg box shown in the figure slides down a smooth vertical wall while you push it with a force ***F*** at a 30° angle from the horizontal. What magnitude of the force *F* (in N) should you apply to let the box slide down at a constant speed?



33 44 23 39 12

57. **

As shown in the figure, a force ***F*** of magnitude 12 N is pulling a box of mass m_2 = 1.0 kg up an inclined plane (θ = 37°). The box is connected by a cord to another box of mass m_1= 3.0 kg on the floor. The floor, plane, and pulley are frictionless, and the masses of the pulley and cord are negligible. What is the tension (in N) in the cord?



5.5 2.2 4.6 1.3 6.4

58. *

The density of salt water is 1.02 greater than the density of fresh water. A box floats in static equilibrium in both fluids. Which of the following statements is correct?

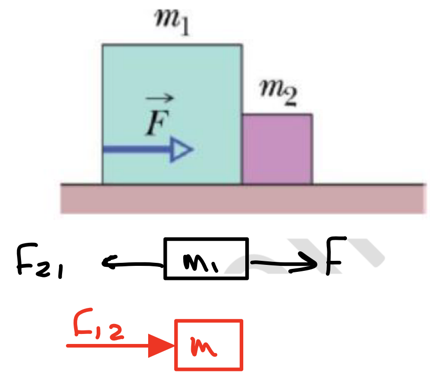
The volume of the displaced water is the same in both cases.
Buoyant force excreted by salt water is greater than that by fresh water.
Buoyant force is the same in both.
Buoyant force excreted by fresh water is greater than that by salt water.
None of the statements is correct.

59. *

A radioactive sample with decay rate *R* and decay energy *Q* has a power output of

55. **

Two blocks, with $m_1 = 2.5$ kg and $m_2 = 1.5$ kg, are in contact on a horizontal frictionless table. A horizontal force F is applied to the larger block, as shown. If the magnitude of the force between the two blocks is 1.2 N, what is the magnitude of the applied force F (in N)? 2.0 3.2 2.4 1.2 5.6



$F - F_{21} = 2.5\,a$

$F - 1.2 = 2.5 * 0.8$

$F = 3.2\ N$

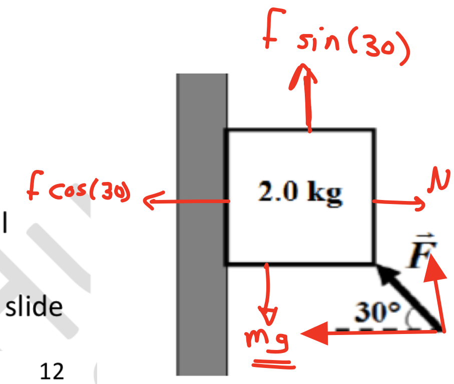
$F_{12} = 1.5 * a$

$1.2 = 1.5\,a$

$\therefore a = 0.8\ m/s^2$

56. **

The 2.0 kg box shown in the figure slides down a smooth vertical wall while you push it with a force ***F*** at a 30° angle from the horizontal. What magnitude of the force *F* (in N) should you apply to let the box slide down at a constant speed? 33 44 23 39 12

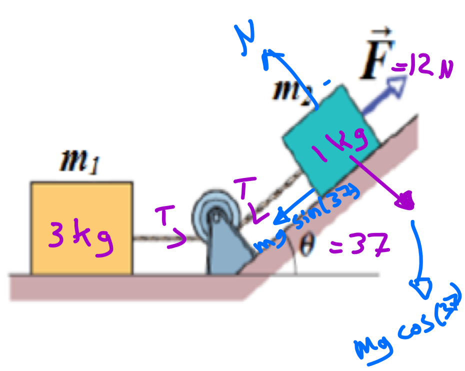


$mg - F\sin(30) = 0$

$mg = F\sin(30) \longrightarrow F = \frac{2 * 9.8}{\sin(30)} \quad \therefore F = 39.2\ N$

57. **

As shown in the figure, a force ***F*** of magnitude 12 N is pulling a box of mass $m_2 = 1.0$ kg up an inclined plane (θ = 37°). The box is connected by a cord to another box of mass $m_1 = 3.0$ kg on the floor. The floor, plane, and pulley are frictionless, and the masses of the pulley and cord are negligible. What is the tension (in N) in the cord?



5.5 2.2 4.6 1.3 6.4

$F - T - m_2 g \sin(37) = m_2 a$

$12 - 3a - m_2 g \sin(37) = m_2 a$

$12 - 3a - 9.8 * \sin(37) = a$

$4a = 6.1$

$a = 1.53\ m/s^2$

$T = 3a \dashrightarrow (1)$

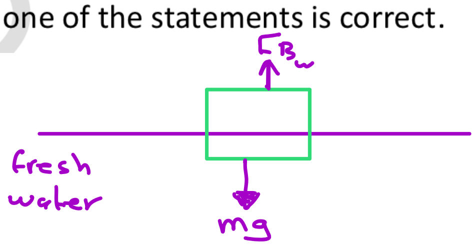
$T = 3 * 1.53$

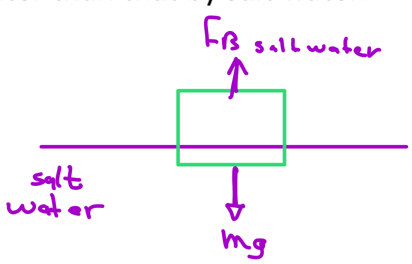
$T = 4.6\ N$

58. *

The density of salt water is 1.02 greater than the density of fresh water. A box floats in static equilibrium in both fluids. Which of the following statements is correct?

The volume of the displaced water is the same in both cases.
Buoyant force excreted by salt water is greater than that by fresh water.
Buoyant force is the same in both.
Buoyant force excreted by fresh water is greater than that by salt water.
None of the statements is correct.





$F_{B_w} = mg$

$F_{B_{salt}} = mg$

$\therefore F_{B_w} = F_{B_{salt}}$

59. *

A radioactive sample with decay rate *R* and decay energy *Q* has a power output of

average power = rate of doing work or it's the amount of energy transferred or converted per unit time

Power = Q R

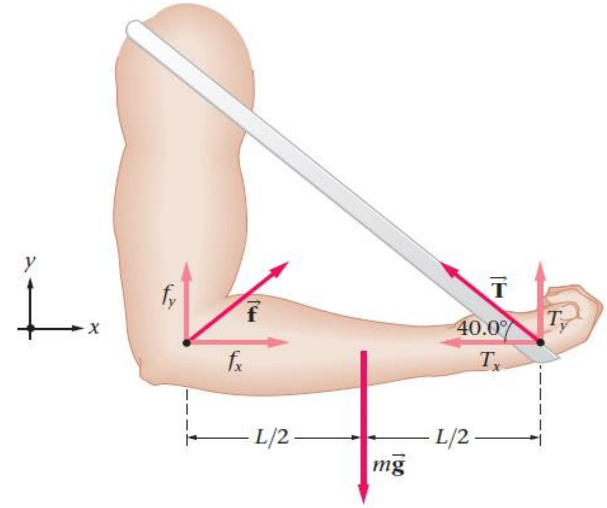
60. *

A certain nucleus containing 8 protons and 7 neutrons has a radius *R*.
Which of the following values would be closest to the expected value of the radius of a nucleus having 51 protons and 69 neutrons?

1.85*R* 2.00*R* 2.14*R* 6.38*R* 8.00*R*

61. **

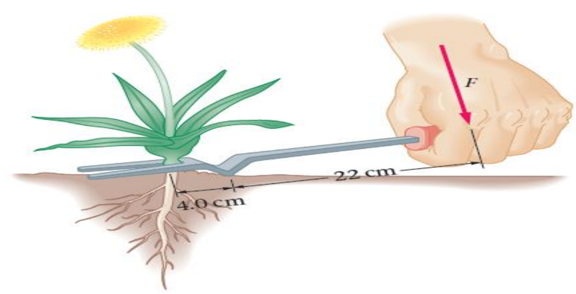
A freshman dental student has a broken forearm (hmm… most likely caused by a combination of tensile and shearing stresses from his/her upcoming PHY_105 final exam!). A cord -stretching from the shoulder to the hand- does hold the forearm **level**. The cord makes an angle of 40.0° with the horizontal. Considering the forearm and hand to be uniform, with a total mass of 1.30 kg and a length of 0.300 m, find: (a) the tension in the cord, **T**.
(b) the horizontal and vertical components of the force, **f**, exerted by the humerus (the bone of the upper arm) on the radius and ulna (the bones of the forearm).



T = 9.92 N, f_x = 7.60 N, and f_y = 6.38 N

62. *

The gardening tool shown is used to pull weeds.
If a 1.23 N.m torque is required to pull a given weed, what force did the weed exert on the tool?
F_{weed} = 31 N.



63. *

The speed of light changes when it goes from ethyl alcohol (*n* = 1.36) to carbon tetrachloride (*n* = 1.46). The ratio of the speed in carbon tetrachloride to the speed in ethyl alcohol is:

1.99 1.07 0.932 0.511 0.760

64. *

A layer of water (*n* = 1.333) floats on carbon tetrachloride (*n* = 1.461) contained in an aquarium. To the nearest degree, what is the critical angle at the interface between the two liquids?

88° 78° 66° 58° 43°

60. *

A certain nucleus containing 8 protons and 7 neutrons has a radius *R*.
Which of the following values would be closest to the expected value of the radius of a nucleus having 51 protons and 69 neutrons?

$A = Z + N = 15$

$R = 1.2 \times 10^{-15} \times \sqrt[3]{15}$

$A_* = Z_* + N_* = 120$

$R_* = 1.2 \times 10^{-15} \sqrt[3]{120}$

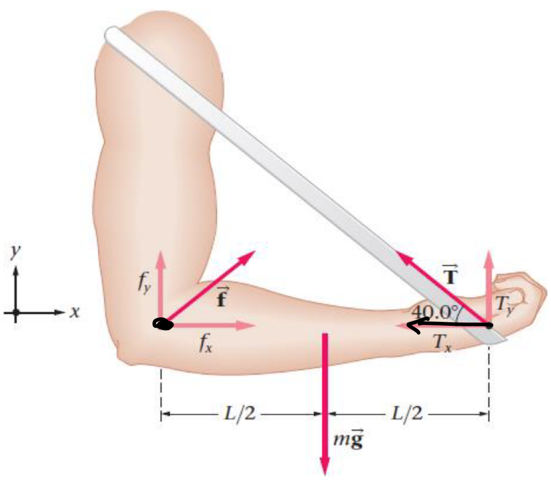
$\frac{R}{R_*} = \frac{1.2 \times 10^{-15} \sqrt[3]{15}}{1.2 \times 10^{-15} \sqrt[3]{120}}$

$\frac{R}{R_*} = \frac{1}{2}$

$\therefore R_* = 2R$

61. **

A freshman dental student has a broken forearm (hmm... most likely caused by a combination of tensile and shearing stresses from his/her upcoming PHY_105 final exam!). A cord -stretching from the shoulder to the hand- does hold the forearm **level**. The cord makes an angle of 40.0° with the horizontal. Considering the forearm and hand to be uniform, with a total mass of 1.30 kg and a length of 0.300 m, find: (a) the tension in the cord, **T**.
(b) the horizontal and vertical components of the force, **f**, exerted by the humerus (the bone of the upper arm) on the radius and ulna (the bones of the forearm).



T = 9.92 N, f_x = 7.60 N, and f_y = 6.38 N

$\Sigma \tau = 0$ about f

(A) $-mg \times 0.15 + T \times 0.3 \times \sin(40) = 0$

$T = 9.91$ N

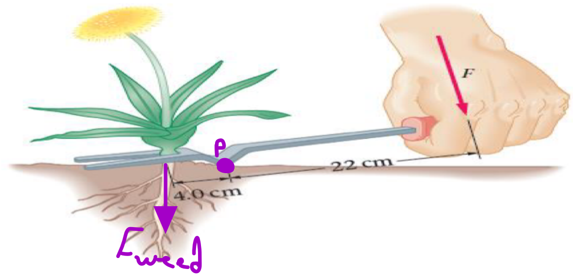
(B) $\Sigma f_x = 0 \rightarrow T_x = f_x \rightarrow f_x = 7.6$ N

$\Sigma f_y = 0 \rightarrow T_y + f_y = mg \rightarrow f_y = 6.4$ N

$$F = \sqrt{6.4^2 + 7.6^2} = 9.94\ N$$

62. *

The gardening tool shown is used to pull weeds. If a 1.23 N.m torque is required to pull a given weed, what force did the weed exert on the tool?



$$\tau_{weed} = F_{weed} * r \sin\theta$$

$$1.23 = F * 0.04 \longrightarrow F = 30.75 \simeq 31\ N$$

63. *

The speed of light changes when it goes from ethyl alcohol (*n* = 1.36) to carbon tetrachloride (*n* = 1.46). The ratio of the speed in carbon tetrachloride to the speed in ethyl alcohol is:

1.99 1.07 0.932 0.511 0.760

$$n_{alcohol} = \frac{c}{V_{alcohol}} \longrightarrow c = V_{alcohol} * n_{alcohol}$$

$$n_{tetra} = \frac{c}{V_{tetra}} \longrightarrow c = n_{tetra} * V_{tetr}$$

$$n_{alc} * V_{alc} = n_{tetra} * V_{tetra} \longrightarrow \frac{V_{tetra}}{V_{alc}} = \frac{n_{alc}}{n_{tetr}} = \frac{1.36}{1.46}$$

$$= 0.932$$

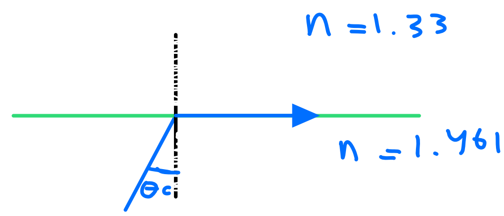
64. *

A layer of water (*n* = 1.333) floats on carbon tetrachloride (*n* = 1.461) contained in an aquarium. To the nearest degree, what is the critical angle at the interface between the two liquids?

88° 78° 66° 58° 43°

$$1.461 * \sin\theta = 1.33 \sin(90)$$

$$\therefore \theta = 65.6 \simeq 66°$$



65. **

Aluminum Rod#1 has a length L and a diameter d. Aluminum Rod#2 has a length 2L and a diameter 2d. If Rod#1 is under tension T and Rod#2 is under tension 2T, how do the changes in length of the two rods compare?

They are the same.
Rod#1 has double the change in length that Rod#2 has.
Rod#2 has double the change in length that Rod#1 has.
Rod#1 has quadruple the change in length that Rod#2 has.
Rod#2 has quadruple the change in length that Rod#1 has.

66. ***

A 2.3 cm thick bar of soap is floating on a water surface so that 1.64 cm of the bar is underwater, as shown in Fig (a). An oil with specific gravity 0.6 is poured into the water as shown in Fig (b).
What is the depth of the oil layer (y_{oil}) (in cm) when the top of the soap is just level with the upper surface of the oil?

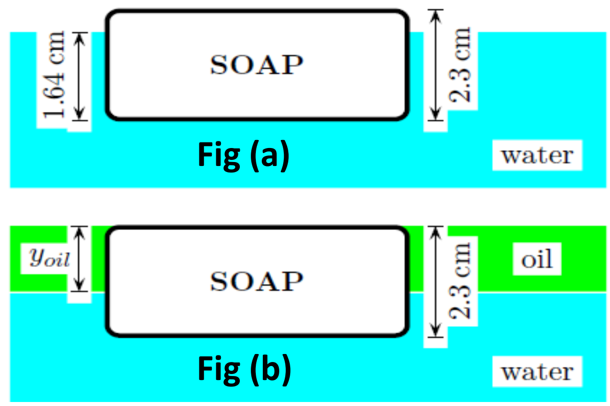


Fig (a)
Fig (b)

1.65 1.10 0.66 1.15 0.34

67. **

A 3-cm high object is in front of a thin lens. The object distance is 4 cm and the image distance is –8 cm. The image height (in cm) is:

0.5 1 1.5 6 24

68. **

Let *p* denote the object-lens distance and *i* the image-lens distance.
The image produced by a lens of focal length *f* has a height that can be obtained from the object height by multiplying it by:

p/*i* *i*/*p* *f*/*p* *f*/*i* *i*/*f*

69. **

A camera with a lens of focal length 6.0 cm takes a picture of a 1.4-m boy standing 11 m away. The height of the image (in cm) is about:

0.39 0.77 1.5 3.0 6.0

70. **

An erect object is 2*f* in front of a convex lens of focal length *f*. The image is:

real, inverted, magnified
real, erect, same size
real, inverted, same size
virtual, inverted, reduced
real, inverted, reduced

65. **

Aluminum Rod#1 has a length L and a diameter d. Aluminum Rod#2 has a length 2L and a diameter 2d. If Rod#1 is under tension T and Rod#2 is under tension 2T, how do the changes in length of the two rods compare?

They are the same.

Rod#1 has double the change in length that Rod#2 has.

Rod#2 has double the change in length that Rod#1 has.

Rod#1 has quadruple the change in length that Rod#2 has.

Rod#2 has quadruple the change in length that Rod#1 has.

Al → Length = L, diameter = d, force = T — Rod #1

Alamium — Rod # 2 — Length = 2L, diameter = 2d, force = 2T

young modulus #1 = young modulus #2 because the same type (Alaminum)

$$\frac{F_1 L_1}{A_1 \Delta L_1} = \frac{F_2 L_2}{A_2 \Delta L_2}$$

$A_1 = \pi \frac{d^2}{4}$

$A_2 = \pi * d^2$

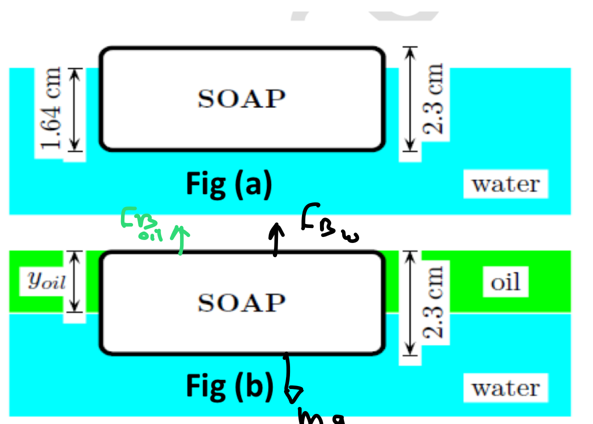
$$\frac{T L}{\frac{\pi d^2}{4} \Delta L_1} = \frac{2T * 2L}{\pi d^2 * \Delta L_2}$$

$$\frac{4}{\Delta L_1} = \frac{4}{\Delta L_2} \quad \therefore \Delta L_1 = \Delta L_2$$

66. ***

A 2.3 cm thick bar of soap is floating on a water surface so that 1.64 cm of the bar is underwater, as shown in Fig (a). An oil with specific gravity 0.6 is poured into the water as shown in Fig (b). What is the depth of the oil layer (y_{oil}) (in cm) when the top of the soap is just level with the upper surface of the oil?

1.65   1.10   0.66   1.15   0.34



$V_{soap} = 2.3\ A$

$V_w = (2.3 - y) * A$

$V_{oil} = y * A$

$\rho_{oil} = 600\ g/cm^3$

$\rho_w = 1000\ g/cm^3$

$$\frac{V_w}{V_o} = \frac{\rho_o}{\rho_w}$$

$$F_{Bw} + F_{B\,oil} = mg$$

$$\rho_w\, g\, V_w + \rho_{oil} * g * V_{oil} = m_o g$$

$$\rho_w g V_w + \rho_{oil} * g * V_{oil} = \rho_o V_o g$$

$$10^3 * (2.3 - y) A + 600 * y * A = 713.04 * 2.3 * A$$

$$2300 - 10^3 y + 600 y = 1640$$

$$660 = 400 y \longrightarrow y = 1.65 \text{ cm}$$

$$\frac{1.64 * A}{2.3 * A} = \frac{\rho_o}{1000}$$

$$\rho_o = 713.04 \ g/cm^3$$

67. **

A 3-cm high object is in front of a thin lens. The object distance is 4 cm and the image distance is –8 cm. The image height (in cm) is: 0.5 1 1.5 6 24

$h_o = 3\text{ cm}$ $d_o = 4\text{ cm}$ $d_i = 8\text{ cm}$ $h_i = ??$

$$\frac{h_o}{d_o} = \frac{h_i}{d_i} = \frac{3}{4} = \frac{h_i}{8} \longrightarrow h_i = 6\text{ cm}$$

68. **

Let *p* denote the object-lens distance and *i* the image-lens distance.
The image produced by a lens of focal length *f* has a height that can be obtained from the object height by multiplying it by: *p/i* *i/p* *f/p* *f/i* *i/f*

$d_o = P$ $d_i = i$ Focal Length $= f$

$$\frac{h_o}{d_o} = \frac{h_i}{d_i - f} \longrightarrow \frac{h_o}{P} = \frac{h_i}{d_i} \longrightarrow h_i = \left(\frac{i}{P}\right) * h_o$$

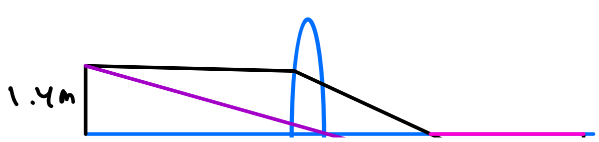
69. **

A camera with a lens of focal length 6.0 cm takes a picture of a 1.4-m boy standing 11 m away. The height of the image (in cm) is about: 0.39 0.77 1.5 3.0 6.0

$f = 6\text{ cm}$ $h_o = 140\text{ cm}$ $d_o = 1100\text{ cm}$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \longrightarrow 6.03\text{ cm} = d_i$$

$$\frac{h_o}{d_o} = \frac{h_i}{d_i}$$



$$\frac{140}{1100} = \frac{h_i}{6.03}$$

$\therefore h_i = 0.77$ cm

70. **

An erect object is 2*f* in front of a convex lens of focal length *f*. The image is:

real, inverted, magnified

virtual, inverted, reduced

real, erect, same size

real, inverted, reduced

real, inverted, same size

real image

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{d_i} = \frac{2/1}{2f} - \frac{1}{2f}$$

$$\frac{1}{d_i} = \frac{1}{2f} \rightarrow d_i = 2f$$

$$\boxed{\therefore d_i = d_o}$$