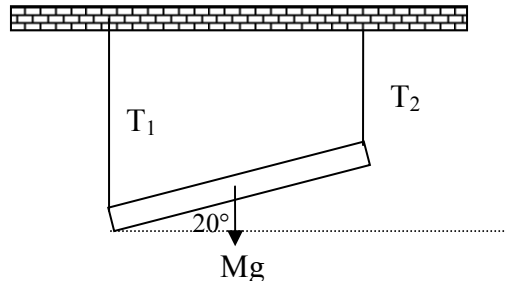


Q1.

A uniform meter stick has mass  $M = 1.25 \text{ kg}$ . As shown in Fig. 1, this meter stick is supported by two vertical strings, one at each end, in such a manner that it makes an angle of  $20^\circ$  with the horizontal. Find the tension in each string.

Fig#

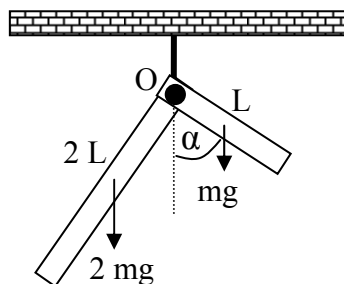


- A)  $T_1 = 6.1 \text{ N}, T_2 = 6.1 \text{ N}$
- B)  $T_1 = 3.4 \text{ N}, T_2 = 5.2 \text{ N}$
- C)  $T_1 = 1.6 \text{ N}, T_2 = 1.2 \text{ N}$
- D)  $T_1 = 7.7 \text{ N}, T_2 = 3.0 \text{ N}$
- E)  $T_1 = 3.2 \text{ N}, T_2 = 3.2 \text{ N}$

Q2.

A thin right angled rod is made of a uniform material. The shorter end is half the length of the longer end. It is hanging by a string attached at point O (Fig. 2). At equilibrium, the angle  $\alpha$  between the shorter rod and the vertical is:

Fig#

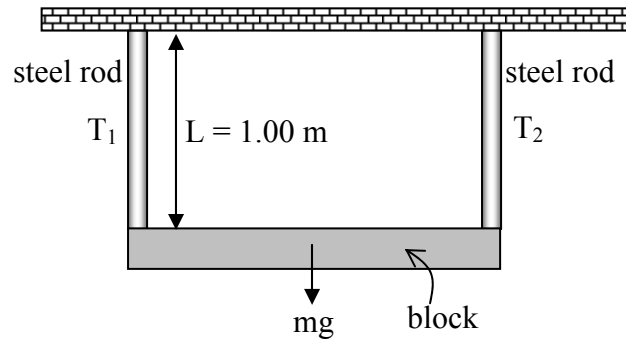


- A)  $76^\circ$
- B)  $18^\circ$
- C)  $31^\circ$
- D)  $21^\circ$
- E)  $59^\circ$

Q3.

Fig. 3 shows a uniform block of mass  $m = 100 \text{ kg}$ , which is held in a horizontal position by two vertical steel rods at its ends. Each of the rods has length,  $L = 1.0 \text{ m}$ , cross sectional area  $= 1.0 \times 10^{-3} \text{ m}^2$  and young's modulus,  $E = 2.0 \times 10^{11} \text{ N/m}^2$ . The increase in the length of any one the rods ( $\Delta L$ ), is:

Fig#



- A)  $2.5 \times 10^{-6}$  m
- B)  $2.5 \times 10^{-4}$  m
- C)  $1.6 \times 10^{-4}$  m
- D)  $1.6 \times 10^{-6}$  m
- E)  $7.7 \times 10^{-4}$  m

Q4.

At what distance above the surface of Earth (radius =  $R$ ) is the magnitude of the gravitational acceleration equal to  $g/16$ ? (Where  $g$  = gravitational acceleration at the surface of Earth).

- A)  $3 R$
- B)  $4 R$
- C)  $5 R$
- D)  $R$
- E)  $16 R$

Q5.

A satellite moves around a planet (of mass  $M$ ) in a circular orbit of radius =  $9.4 \times 10^6$  m with a period of  $2.754 \times 10^4$  s. Find  $M$ .

- A)  $6.5 \times 10^{23}$  kg
- B)  $9.6 \times 10^{25}$  kg
- C)  $2.5 \times 10^{24}$  kg
- D)  $3.8 \times 10^{22}$  kg
- E)  $8.3 \times 10^{21}$  kg

Q6.

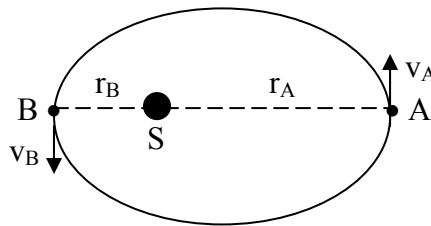
A rocket is launched from the surface of a planet of mass  $M = 1.90 \times 10^{27}$  kg and radius  $R = 7.15 \times 10^7$  m. What minimum initial speed is required if the rocket is to rise to a height of  $6R$  above the surface of the planet? (Neglect the effects of the atmosphere).

- A)  $5.51 \times 10^4$  m/s
- B)  $3.21 \times 10^4$  m/s
- C)  $4.15 \times 10^4$  m/s
- D)  $6.51 \times 10^4$  m/s
- E)  $2.53 \times 10^4$  m/s

Q7.

Fig. 4 shows a planet traveling in a counterclockwise direction on an elliptical path around a star S located at one focus of the ellipse. The speed of the planet at a point A is  $v_A$  and at B is  $v_B$ . The distance AS =  $r_A$  while the distance BS =  $r_B$ . The ratio  $v_A/v_B$  is:

Fig#

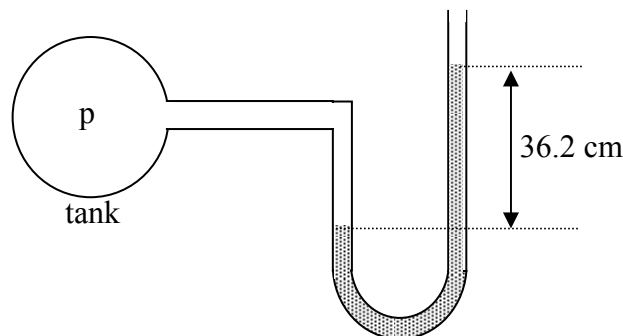


- A)  $(r_B/r_A)$
- B)  $(r_B/r_A)^2$
- C)  $(r_A/r_B)$
- D)  $(r_A/r_B)^2$
- E)  $(r_B/r_A)^{0.5}$

Q8.

The pressure of a gas in a tank is measured with a mercury manometer (Fig. 5). The mercury is 36.2 cm higher in the outside arm than in the arm connected to the gas cell. Find the gauge pressure of the gas cell. (Density of mercury is  $13.6 \text{ g/cm}^3$ )

Fig#

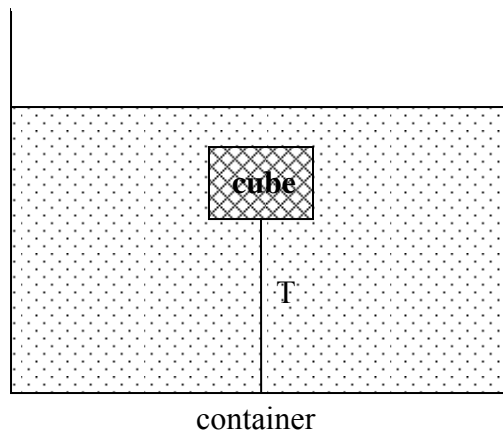


- A)  $4.82 \times 10^4 \text{ Pa}$
- B)  $1.01 \times 10^6 \text{ Pa}$
- C)  $2.50 \times 10^4 \text{ Pa}$
- D)  $3.75 \times 10^6 \text{ Pa}$
- E)  $6.13 \times 10^5 \text{ Pa}$

Q9.

A cube of wood of side = 10 cm has a density of  $700 \text{ kg/m}^3$ . As shown in Fig. 6, the cube is held in equilibrium under water by a string tied to the BOTTOM of a container. Find the tension in the string.

Fig#



- A) 2.94 N
- B) 5.04 N
- C) 1.32 N
- D) 0.54 N
- E) 7.13 N

Q10.

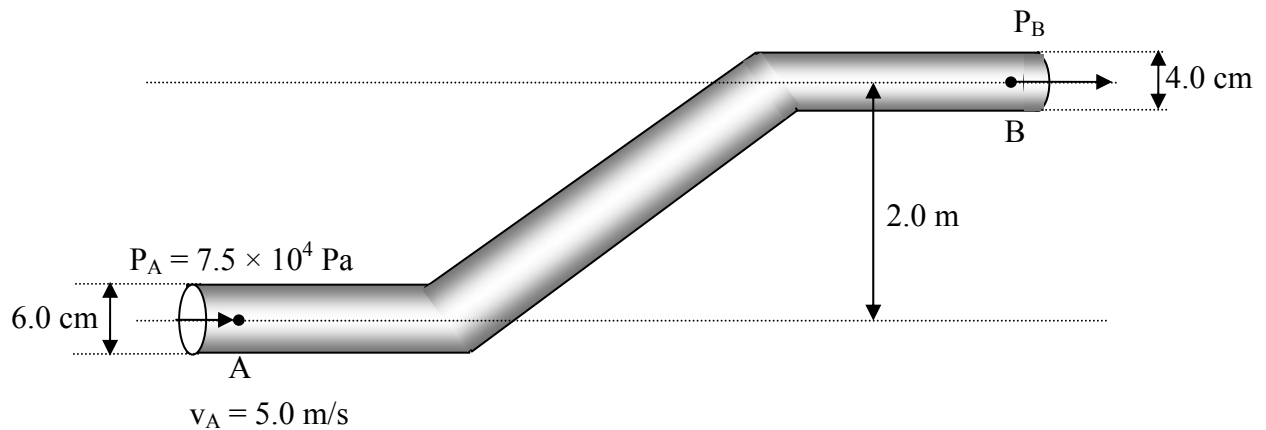
A garden hose has an inner diameter of 16 mm. The hose can fill a 10 liter bucket in 20 s. Find the speed of the water at the end of the hose (1 Liter =  $10^{-3} \text{ m}^3$ ).

- A) 2.5 m/s
- B) 1.3 m/s
- C) 5.6 m/s
- D) 0.5 m/s
- E) 7.0 m/s

Q11.

Water flows through a pipe as shown in Fig. 7. At the lower elevation, the water's speed ( $v_A$ ) is 5.0 m/s and the gauge pressure ( $P_A$ ) is  $7.5 \times 10^4 \text{ Pa}$ . Find the gauge pressure at the higher elevation ( $P_B$ ). (Diameter at A = 6.0 cm, diameter at B = 4.0 cm and the elevation of B relative to A is 2.0 m)

Fig#



- A) 4.60 kPa
- B) 101 kPa
- C) 1.01 kPa
- D) 75.0 kPa
- E) 2.45 kPa

Q12.

A 2.00 kg uniform meter stick ( $L = 1.00 \text{ m}$ ) is pivoted at one of its end and made to oscillate in a vertical plane about this end. The period of oscillation is:

- A) 1.64 s
- B) 0.260 s
- C) 5.34 s
- D) 7.81 s
- E) 9.11 s

Q13.

A 0.20 kg object attached to a horizontal spring whose spring constant is 500 N/m executes simple harmonic motion. If its maximum speed is 5.0 m/s, the amplitude of its oscillation is:

- A) 0.10 m
- B) 0.0020 m
- C) 0.20 m
- D) 25 m
- E) 250 m

Q14.

A 3.0 kg block, attached to a spring, executes simple harmonic motion according to the relation:  $x = 2.0 \cos(50t)$ , where  $x$  is in m and  $t$  is in s. The spring constant of the spring is:

- A)  $7.5 \times 10^3 \text{ N/m}$
- B)  $1.0 \times 10^2 \text{ N/m}$
- C)  $4.5 \times 10^2 \text{ N/m}$
- D)  $1.5 \times 10^3 \text{ N/m}$
- E)  $2.5 \times 10^3 \text{ N/m}$

Q15.

A particle is in simple harmonic motion along the  $x$  axis. The amplitude of the motion is  $x_m$ . When it is at  $x = 10$  cm, its kinetic energy  $K = 6.0$  J and its potential energy  $U = 4.0$  J (measured with  $U = 0$  at  $x = 0$ ). When it is at  $x = -5.0$  cm, the kinetic and potential energies are:

- A)  $K = 9.0$  J and  $U = 1.0$  J
- B)  $K = 6.0$  J and  $U = -4.0$  J
- C)  $K = 6.0$  J and  $U = 4.0$  J
- D)  $K = 0$  and  $U = 10.0$  J
- E)  $K = 0$  and  $U = -10.0$  J

Q16.

Suppose  $A = B/C$ , where  $A$  has the units kg/s and  $C$  has the units m/s. Then  $B$  has the units of:

- A) force
- B) power
- C) energy
- D) linear momentum
- E) angular momentum

Q17.

A stone is released from a balloon that is descending (moving downward) at a constant speed of  $10.0$  m/s. Neglecting air resistance, after  $20.0$  s the speed of the stone is:

- A)  $206$  m/s
- B)  $2160$  m/s
- C)  $1760$  m/s
- D)  $196$  m/s
- E)  $186$  m/s

Q18.

Vectors  $\vec{A}$  and  $\vec{B}$  are such that the magnitude of  $\vec{A} \times \vec{B}$  is 6 units and  $\vec{A} \cdot \vec{B}$  is equal to 6 units. What is the angle between  $A$  and  $B$ ?

- A)  $45^\circ$
- B)  $0^\circ$
- C)  $90^\circ$
- D)  $30^\circ$
- E)  $60^\circ$

Q19.

A stone is thrown from the top of a  $60.0$  m high cliff with an initial velocity

$\vec{v}_o = (10.0\hat{i} + 20.0\hat{j})$  m/s. How long will the stone be in the air before hitting the ground?

- A)  $6.09$  s
- B)  $4.01$  s
- C)  $5.50$  s
- D)  $7.88$  s

E) 8.20 s

Q20.

A 5.0 kg concrete block is lowered with a downward acceleration of  $2.8 \text{ m/s}^2$  by means of a rope. The tension in the rope is:

- A) 35 N
- B) 14 N
- C) 20 N
- D) 11 N
- E) 49 N

Q21.

When a 25.0 kg box is pushed across a frictionless horizontal floor with a force of 200.0 N, directed  $20.0^\circ$  below the horizontal, the magnitude of the normal force of the floor on the box is:

- A) 313 N
- B) 25.0 N
- C) 68.0 N
- D) 182 N
- E) 255 N

Q22.

A car goes around a flat, horizontal circle at a constant speed of 18 m/s. A ball is suspended by a string from the ceiling of the car. The ball then describes a circle of radius 75 m as the car rounds the curve. The angle between the string and the vertical is:

- A)  $24^\circ$
- B)  $0^\circ$
- C)  $1.4^\circ$
- D)  $90^\circ$
- E)  $66^\circ$

Q23.

A 4.0 kg cart starts up an incline with a speed of 3.0 m/s and comes to rest 2.0 m up the incline. The total work done on the car is:

- A) -18 J
- B) 6.0 J
- C) -8.0 J
- D) 12 J
- E) -24 J

Q24.

A 2.0 kg block starts from rest on a rough inclined plane that makes an angle of  $30^\circ$  with the horizontal. The coefficient of kinetic friction is 0.25. As the block goes 2.0 m down the plane, the kinetic energy of the block is:

- A) 11 J

- B)  $-9.8 \text{ J}$
- C)  $9.8 \text{ J}$
- D)  $2.0 \text{ J}$
- E)  $18 \text{ J}$

Q25.

An ideal spring is used to fire a  $15.0 \text{ g}$  pellet horizontally. The spring has a spring constant of  $20 \text{ N/m}$  and is initially compressed by  $7.0 \text{ cm}$ . The kinetic energy of the pellet as it leaves the spring is:

- A)  $4.9 \times 10^{-2} \text{ J}$
- B) zero
- C)  $2.5 \times 10^{-2} \text{ J}$
- D)  $9.8 \times 10^{-2} \text{ J}$
- E)  $1.4 \text{ J}$

Q26.

Cart A, with a mass of  $0.20 \text{ kg}$ , travels on a horizontal air track at  $3.0 \text{ m/s}$  and hits cart B, which has a mass of  $0.40 \text{ kg}$  and is initially moving in the same direction as A at  $2.0 \text{ m/s}$ . After the collision the center of mass of the two cart system has a speed of:

- A)  $2.3 \text{ m/s}$
- B) zero
- C)  $0.33 \text{ m/s}$
- D)  $2.5 \text{ m/s}$
- E)  $5.0 \text{ m/s}$

Q27.

Two bodies, A and B, have equal kinetic energies. The mass of A is nine times that of B. The ratio of the momentum of A to that of B ( $P_A/P_B$ ) is:

- A) 3
- B)  $1/9$
- C)  $1/3$
- D) 1
- E) 9

Q28.

A disk with a rotational inertia of  $5.0 \text{ kg}\cdot\text{m}^2$  and a radius of  $0.25 \text{ m}$  rotates about a frictionless fixed axis perpendicular to the disk through its center. A force of  $8.0 \text{ N}$  is applied tangentially to the rim. If the disk starts at rest, then after it has turned through half a revolution its angular velocity is:

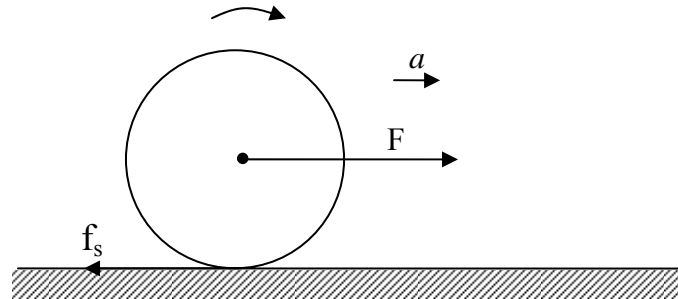
- A)  $1.6 \text{ rad/s}$
- B)  $0.57 \text{ rad/s}$
- C)  $0.64 \text{ rad/s}$
- D)  $0.80 \text{ rad/s}$
- E)  $3.2 \text{ rad/s}$

Q29.



Fig. 8 shows a solid disk with mass  $M$ , radius  $R$ , and rotational inertia  $\frac{1}{2} MR^2$ , rolling without sliding on a horizontal surface. A horizontal force  $F$  is applied to the axle and the center of mass has an acceleration  $= a$ . The magnitude of the frictional force ( $f_s$ ) of the surface is:

Fig#



- A)  $\frac{1}{2} M a$
- B) 0
- C)  $2 M a$
- D)  $M a$
- E)  $\frac{1}{4} M a$

Q30.

A 2.0 kg stone is tied to a 0.50 m long string moves in a circle at a constant angular velocity of 12 rad/s. The net torque on the stone about the center of the circle is:

- A) 0
- B)  $6.0 \text{ N} \cdot \text{m}$
- C)  $12 \text{ N} \cdot \text{m}$
- D)  $72 \text{ N} \cdot \text{m}$
- E)  $140 \text{ N} \cdot \text{m}$