Q1.

Fig. 1 shows a three boxes of masses m_1, m_2 and m_3 hanging from a ceiling. The crossbars are horizontal and have negligible mass and same length L. If m_3 = 1.0 kg, then m_1 is equal to:

Fig#

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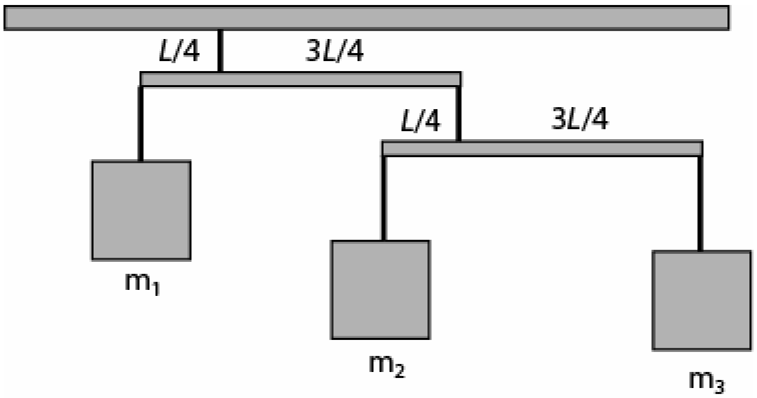

A) 12 *kg*
B) 8.0 *kg*
C) 2.0 *kg*
D) 4.0 *kg*
E) 10 *kg*

Q2.

Fig. 2 shows a uniform beam with a weight of 60.0 *N* and length of 3.20 *m* is hinged at its lower end and a horizontal force F of magnitude 50.0 *N* acts at its upper end. The beam is held vertical by a cable that makes an angle θ = 30.0° with the ground and is attached to the beam at a height h = 1.60 *m*. The tension (T) in the cable is:

Fig#

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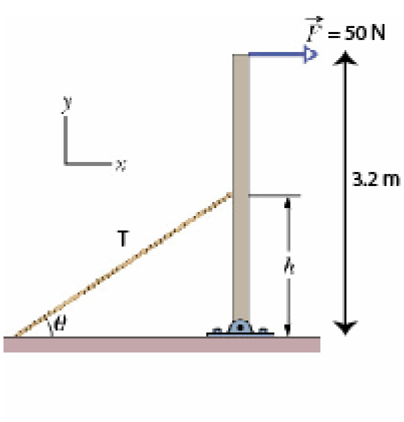

A) 115 N
B) 160 N

C) 46 N
D) 80 N
E) 35 N

Q3.
A solid copper sphere has a diameter of 85.5 cm. How much stress must be applied to the sphere to reduce its diameter to 85.0 cm? The bulk modulus of copper is 1.4 x 10^{11} N/m^2

A) 2.4×10^9 N/m^2
B) 1.5×10^{10} N/m^2
C) 7.0×10^{10} N/m^2
D) 9.5×10^9 N/m^2
E) 2.8×10^{11} N/m^2

Q4.
A uniform disk is rolling smoothly down a rough incline starting from rest from a height *h* as shown in the Fig. 3. Which one of the following statement is correct?

Fig#

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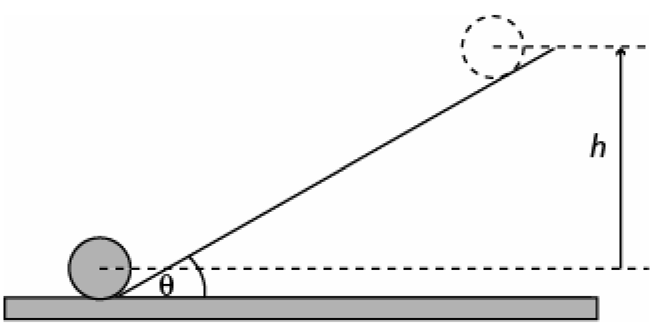

A) Kinetic energy of rolling of the disk at the bottom of the incline is *mgh*
B) Mechanical energy is not conserved because there is friction
C) Rotational kinetic energy $\left(\frac{1}{2}I_{com}\omega^2\right)$ is equal to the translational kinetic energy $\left(\frac{1}{2}mv_{com}^2\right)$ at the bottom.
D) No change in rotational kinetic energy
E) Work done by static friction force is not zero.

Q5.
A wheel turns through 5.0 *rev* as it slows down at a constant rate from an initial angular speed of 2.51 *rad/s* to a stop. The angular acceleration of the wheel is:

A) − 0.10 rad/s^2

B) + 0.10 *rad/s*^{2}
C) − 0.20 *rad/s*^{2}
D) + 0.20 *rad/s*^{2}
E) −0.50 *rad/s*^{2}

Q6.
A playground merry-go-round has a radius (R) of 3.0 *m* and a rotational inertia of 320 *kg·m*^{2}. It is initially spinning at 0.80 *rad/s* when a 20 *kg* child, initially standing at the center, walks from the center to the rim ($r = R$). When the child reaches the rim the angular velocity of the merry-go-round is:
(You can consider the child to be a point mass).

A) 0.51 *rad/s*
B) 0.73 *rad/s*
C) 0.80 *rad/s*
D) 0.89 *rad/s*
E) 1.1 *rad/s*

Q7.
Fig. 4 shows an ideal fluid flow in a horizontal tube. The pressure, velocity, and cross sectional area of fluid at point 1 and 2 are (P_1, v_1, A_1) and (P_2, v_2, A_2) respectively with $A_1 > A_2$. Which one of the following statements is correct?

Fig#

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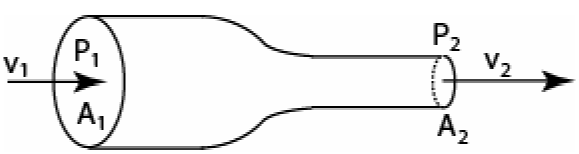

A) $v_1 < v_2$ & $P_1 > P_2$
B) $v_1 = v_2$ & $P_1 = P_2$
C) $v_1 < v_2$ & $P_1 < P_2$
D) $v_1 > v_2$ & $P_1 > P_2$
E) $v_1 < v_2$ & $P_1 = P_2$

Q8.
A wooden box has been found to floats in three different fluids of densities: ρ_1 (fluid 1) = 0.9 *g/cm*^{3}, ρ_2 (fluid 2) = 1.0 *g/cm*^{3}, ρ_3 (fluid 3) = 1.1 *g/cm*^{3}. Which one of the following statements is true?

A) the three fluids exert the same buoyant force
B) the buoyant force of fluid 1 is greater than the buoyant forces of the other two fluids

C) the buoyant force of fluid 3 is greater than the buoyant forces of the other two fluids
D) the object displace the same volume of all three fluids
E) none of these are true

Q9.
A U-tube of constant cross sectional area, open to the atmosphere, is partially filled with Hg (ρ_{Hg}=13.6 g/cm^3). Water (ρ_w=1.00 g/cm^3) is then poured into both arms. If the equilibrium configuration of the tube is as shown in the Fig. 5 with h_3= 1.00 cm, determine the value of h_1. (Note that h_1, h_2 and h_3 are not drawn to scale).

Fig#

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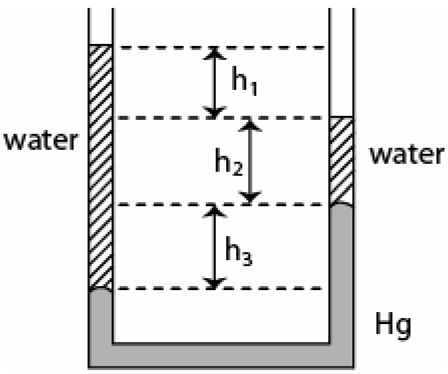

A) 12.6 *cm*
B) 0 *cm*
C) 13.6 *cm*
D) 3.0 *cm*
E) 2.6 *cm*

Q10.
The open end of a cylindrical pipe has a radius of 1.5 *cm*. Water (density = 1.0×10^3 *kg/m*^{3}) flows steadily out of this end at a speed of 7.0 *m/s*. The rate at which mass is leaving the pipe is:

A) 4.9 *kg/s*
B) 2.5 *kg/s*
C) 7.0 *kg/s*
D) 48 *kg/s*
E) 7.0 × 10^3 *kg/s*

Q11.
A particle of mass *m* = 2.0 kg is attached to a string and swings in a vertical circle of radius *r* = 0.50 *m*. What is the tension (T) in the string at the moment the string makes an angle of 60° with the vertical and has a speed of 3.0 *m/s*? (See Fig. 6).

Fig#

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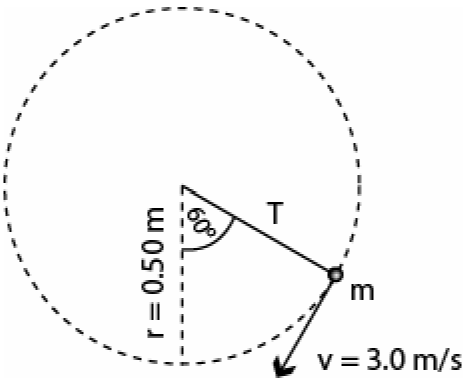

A) 46 *N*
B) 20 *N*
C) 9.8 *N*
D) 15 *N*
E) 32 *N*

Q12.
A 40-*kg* block is dragged along a horizontal surface by a force *F* = 260 *N* applied on the block at an angle of 30° as shown in Fig. 7. The coefficient of kinetic friction is μ_k = 0.40 and the block moves at constant acceleration of *a*. The magnitude of *a* is:

Fig#

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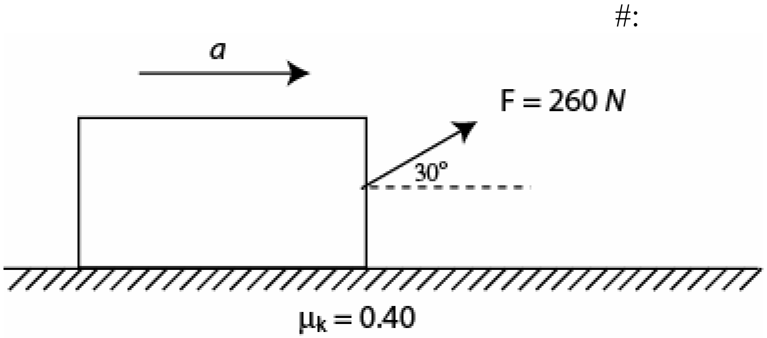

A) 3.0 m/s^2
B) 1.0 m/s^2
C) 2.0 m/s^2
D) 4.0 m/s^2
E) 5.0 m/s^2

Q13.

Only two forces $\left(\vec{F}_1 \text{ and } \vec{F}_2\right)$ are acting on a particle of mass 3.0 *kg* that moves with an acceleration of 3.0 m/s^2 in the positive direction of *y*-axis. If $\vec{F}_1 = \left(8.0\,\hat{i}\right) N$, what is the magnitude of $\vec{F}_2$?

A) 12 *N*
B) 1.0 *N*
C) 17 *N*
D) 15 *N*
E) 9.0 *N*

Q14.
The displacement of a particle oscillating along the x-axis is given as a function of time according to the equation: $x(t) = 0.50\cos\left(\pi t + \frac{\pi}{2}\right)$. The magnitude of the maximum acceleration of the particle is:

A) 4.9 m/s^2
B) impossible to determine
C) zero
D) 9.8 m/s^2
E) 1.8 m/s^2

Q15.
A block of mass 2.0 *kg* attached to a spring oscillates in simple harmonic motion along the *x* axis. The limits of its motion are $x = -20$ *cm* and $x = +20$ *cm* and it goes from one of these extremes to the other in 0.25 *s*. The mechanical energy of the block-spring system is:

A) 6.3 *J*
B) 1.2 *J*
C) 2.5 *J*
D) 5.3 *J*
E) 4.1 *J*

Q16.
The mechanical energy of a block-spring system executing simple harmonic motion is 8.0 *J* and the amplitude x_m=12 *cm*. When $K = 6.0$ *J*, the displacement of the block is:

A) $x = 6.0$ *cm*
B) $x = 4.0$ *cm*
C) $x = 12$ *cm*
D) $x = -3.0$ *cm*

E) $x = 0\ cm$

Q17.
A physical pendulum consists of a uniform solid disk (radius $R = 10.0\ cm$) supported in a vertical plane by a pivot located at a distance $d = 5.0\ cm$ from the center of the disk. The disk is made to oscillate in a simple harmonic motion of period T. Find T.

A) 0.78 *s*
B) 1.4 *s*
C) 1.0 *s*
D) 0.38 *s*
E) 1.8 *s*

Q18.
Car *A* is moving with velocity $\left(20\,\hat{i}\right) m/s$ and car *B* is traveling with velocity $\left(30\,\hat{j}\right) m/s$. What is the velocity of car *A* relative to *B*?

A) $\left(20\,\hat{i} - 30\,\hat{j}\right) m/s$
B) $\left(30\,\hat{i} - 20\,\hat{j}\right) m/s\ s$
C) $\left(20\,\hat{i} + 30\,\hat{j}\right) m/s$
D) $\left(-20\,\hat{i} + 30\,\hat{j}\right) m/s$
E) $\left(-20\,\hat{i} - 30\,\hat{j}\right) m/s$

Q19.
$\vec{A} = \hat{i} + \hat{j}$, $\vec{B} = \hat{i} - \hat{j}$ and $\vec{C} = 2\hat{k}$. What is the value of $\left(\vec{A} \times \vec{B}\right) \cdot \vec{C}$:

A) -4
B) 0
C) 1
D) $\hat{i} + 2\hat{k}$
E) $\hat{k}$

Q20.
A particle leaves the origin with an initial velocity, $\vec{v}_o = \left(4.0\,\hat{i}\right) m/s$ and a constant acceleration $\vec{a} = \left(-2.0\,\hat{i} - 0.50\,\hat{j}\right) m/s$. It reaches its maximum *x*-coordinate at:

A) 2.0 *s*
B) 1.0 *s*
C) 3.0 *s*
D) 4.0 *s*
E) 5.0 *s*

Q21.
A large cannon is fired from the ground at an angle of 45° above the horizontal. The initial speed is 980 *m/s*. Neglecting air resistance, the projectile will travel a horizontal distance = *X* before striking the ground. Find *X*.

A) 98 *km*
B) 25 *km*
C) 85 *km*
D) 49 *km*
E) 170 *km*

Q22.
An object *A* has mass *m* and is moving with velocity 15 *m/s*. It then collides and sticks with a stationary object *B* of mass 2 *m*. The velocity of the composite object (mass 3*m*) after collision is:

A) 5.0 *m/s*
B) 10 *m/s*
C) 15 *m/s*
D) −10 *m/s*
E) 7.5 *m/s*

Q23.
A 2.0 *kg* cart, traveling on a horizontal air track with a speed of 3.0 *m/s*, collides with a stationary 4.0 *kg* cart. The carts stick together. The impulse exerted by one cart on the other has a magnitude of:

A) 4.0 *N·s*
B) 0
C) 6.0 *N·s*
D) 9.0 *N·s*
E) 1.0 *N·s*

Q24.

A box of mass = 10.0 kg is placed at the top of a 30.0º inclined plane. The box starts from rest and slides down the incline. The frictional force on the box during the slide is 25.0 *N*. After traveling 12.0 *m*, its kinetic energy is:

A) 288 *J*
B) 144 *J*
C) 980 *J*
D) 490 *J*
E) 0 *J*

Q25.
A force of 120 *N* stretches a certain spring a distance of 0.10 *m*. What is the elastic potential energy of the spring when it is compressed 0.10 *m*?

A) 6.0 *J*
B) 2.0 *J*
C) 4.0 *J*
D) 8.0 *J*
E) 10 *J*

Q26.
A 2.0 *kg* box has an initial velocity of 10 *m*/*s* in the positive *x*-direction. A net force of 5.0 *N* caused the box to move with a velocity of 10 *m*/*s* in the positive *y*-direction. The work done on the box by this force is:

A) 0
B) 10 *J*
C) 50 *J*
D) 25 *J*
E) 5 *J*

Q27.
Eight balls of different masses are placed along a circle as shown in Fig. 8 The net force on a ninth ball of mass *m* in the center of the circle is in the direction of:

Fig#

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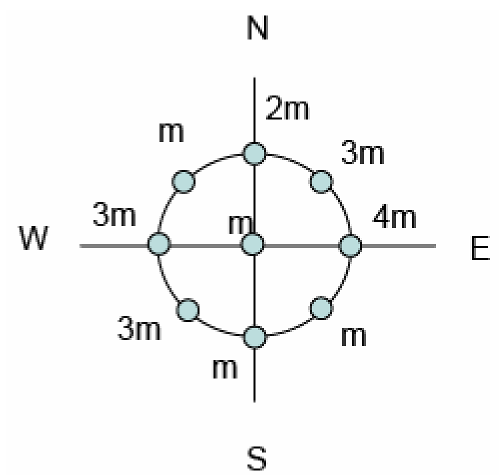

A) NE
B) SE
C) E
D) N
E) W

Q28.
The escape velocity of an object of mass 200 *kg* on a certain planet is 60 *km/s*. When the object is on the surface of the planet, the gravitational potential energy of the object-planet system is:

A) -3.6×10^{11} *J*
B) $+ 3.6 \times 10^{11}$ *J*
C) $- 3.6 \times 10^{5}$ *J*
D) $+ 3.6 \times 10^{5}$ *J*
E) 0 *J*

Q29.
A planet has two moons of masses $m_1 = m$ and $m_2 = 2m$ and orbit radii $r_1 = r$ and $r_2 = 2r$, respectively. The ratio of their periods T_1/T_2 is:

A) 0.35
B) 0.13
C) 1
D) 4
E) 0.71

Q30.
A satellite in a circular orbit around Earth has a kinetic energy of 1.0×10^{8} *J*. The mechanical energy of the stellite-Earth system is:

A) $-1.0 \times 10^8\ J$
B) $1.0 \times 10^8\ J$
C) $-2.0 \times 10^8\ J$
D) $+ 2.0 \times 10^8\ J$
E) $0\ J$