49. Elektrijada, Budva 2009.

Test in Physics

Remark: Every task weigths 5 points. Only correct answer with detailed procedure and adequate explanation will marked adequate number of points. Only correctly answered tasks will be considered.

1. One strategy in a snowball fight is to throw a first snowball at a high angle over level ground. While your opponent is watching the first one, you throw a second one at a low angle and timed to arrive at your opponent before or at the same time as the first one. Assume both snowballs are thrown with a speed of 25m/s. The first one is thrown at an angle of 70^0 with respect to the horizontal. At what angle should the second (low-angle) snowball be thrown if it is to land at the same point as the first? How many seconds later should the second snowball be thrown if it is to land at the same time as the first?

a) 40˚ i 6.1 s   b) 20˚ i 3.05 s   c) 20˚ i 1.743 s

d) 30˚ i 3.05 s   e) 15˚ i 2.05 s

2. A uniform rigid rod AB rotates in horizontal plane about point A, with uniform angular speed ω. The rod is connected to horizontal hoop of the radius R by the ring C (Fig. t-2). What is the acceleration of the ring C.

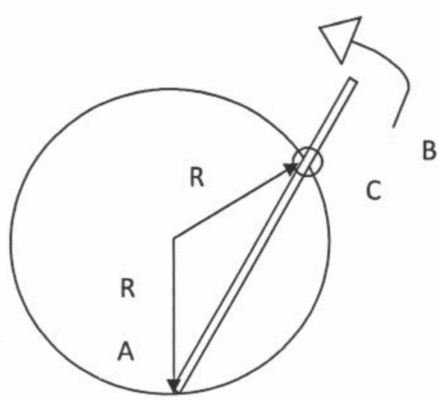

Figure t-2.

a) $2R\omega^2$ b) $4R\omega^2$ c) $R\omega^2$

d) $6R\omega^2$ e) $3R\omega^2$

3. What horizontal force must be applied to the cart shown in Fig. t-3 so that the blocks remain stationary relative to the cart? Assume all surfaces, wheels and pulley are frictionless.

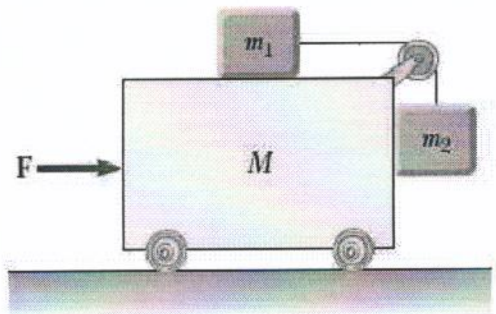

Figure t-3.

a) $F = \frac{m_2}{m_1} g(2M + m_1)$ b) $F = \frac{m_1}{m_2} g(M + m_1 + m_2)$ c) $F = \frac{M}{m_1} g(M + m_1 + m_2)$

d) $F = \frac{m_2}{m_1} g(M + m_1 + m_2)$ e) $F = \frac{m_2}{m_1} g(M + 2m_2)$

4. A car rounds a banked curve as shown in Fig. t-4. The radius of curvature of the road is R=100m, the banking angle is ϑ=10° and the coefficient of static fraction is μ_s=0.1. Determine the range of speeds the car can have without slipping up or down the banked surface.

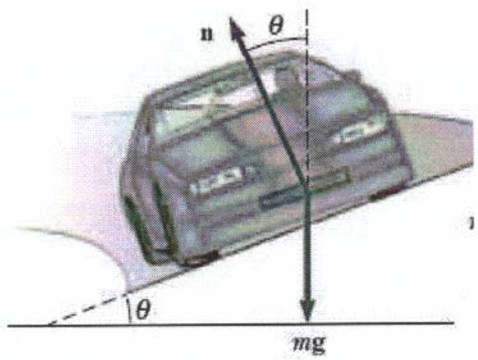

Figure t-4.

a) 8.59 m/s – 16.34 m/s
b) 30.81 m/s – 31.35 m/s
c) 12.35 m/s - 20.01 m/s
d) 5.56 m/s – 10.34 m/s
e) 0 m/s – 40.32 m/s

5. A billiard ball moving at 5m/s strikes a stationary ball of the same mass. After the collision, the first ball moves at 4.33m/s and at the angle of 30^0 with respect to the original line of motion. Assuming an elastic collision find the struck ball's velocity and scattering angle.

a) 2.5 m/s i 45°
b) 5 m/s i 30°
c) 2 m/s i 15°
d) 2.5 m/s i 60°
e) 3 m/s i 55°

6. A two dimensional force is given as $F = (-9x^2y + 7)\mathbf{e}_x - 3x^3\mathbf{e}_y$. Find the work done by this force while moving a body from point M_1 (2, 3) to M_2 (7, 5).

a) 5154 J
b) 5038 J
c) -5154 J
d) -5038 J
e) 5096 J

7. Three objects of uniform density, a solid sphere, a solid cylinder and a hollow cylinder, are placed at the top of an incline (Fig. t-7). If they are all released from rest at the same elevation and roll without slipping, which object reaches the bottom first, and which reaches it last?

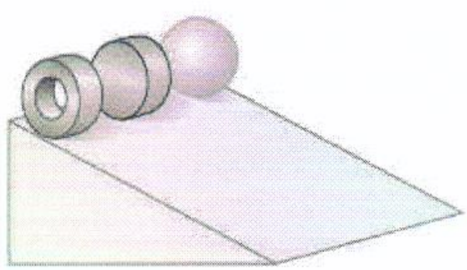

Figure t-7.

a) cilindar i šuplji cilindar

a) lopta i cilindar

b) lopta i šuplji cilindar

d) cilindar i lopta

e) šuplji cilindar i lopta

8. A uniform solid sphere of radius r is placed on the inside surface of a hemispherical bowl of radius $R = 5r$. The sphere is released from rest at an angle ϑ to the vertical and roles without slipping (Fig. t-8). Determine the angular speed of the sphere when it reaches the bottom of the bowl.

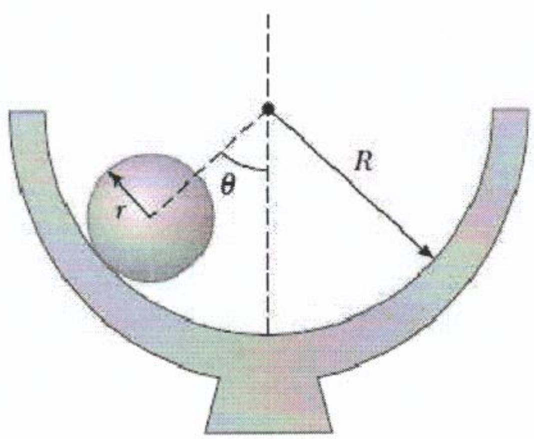

Figure t-8.

a) $\frac{100g(1-\cos\theta)}{13r}$ b) $\frac{40g(1-\cos\theta)}{7r}$ c) $\frac{50g(1-\cos\theta)}{7r}$

d) $\frac{40g(1-\cos\theta)}{13r}$ e) $\frac{100g(1-\cos\theta)}{7r}$

9. Two identical, uniform bricks of length L are placed in a stack over the edge of a horizontal surface such that the maximum possible overhang without falling is achieved, as shown in Fig. t-9. Find the distance x.

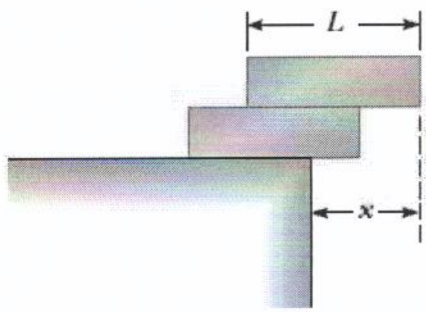

Figure t-9.

a) x = L b) x = 3L/4 c) x = L/2

d) x = L/4 e) x = 2L/5

10. Two pendulums are attached to a massless spring, as shown in Fig. t-20. The arms of the pendulums are of identical lengths l, but the pendulum balls have unequal masses m_1 and m_2. The initial distance between the masses is the equilibrium length of the spring, which has spring constant k. What is the angular frequency of the system?

a) $\sqrt{\frac{g}{l}}$

b) $\sqrt{\frac{k}{m_1 + m_2}}$

c) $\sqrt{\frac{k}{m_1} + \frac{k}{m_2}}$

d) $\sqrt{\frac{g}{l} + \frac{k}{m_1} + \frac{k}{m_2}}$

e) $\sqrt{\frac{2g}{l} + \frac{k}{m_1 + m_2}}$

11. Two stars of masses *M* and *m*, separated by a distance *d*, revolve in circular orbits about their center of mass. What are the periods of these stars?

a) $T_1 = \pi d\sqrt{\frac{d}{\gamma M}}$, $T_2 = \pi d\sqrt{\frac{d}{\gamma m}}$

b) $T_1 = \pi d\sqrt{\frac{d}{\gamma(m+M)}}$, $T_2 = \pi d\sqrt{\frac{d}{\gamma(m+M)}}$

c) $T_1 = 2\pi d\sqrt{\frac{d}{\gamma(m+M)}}$, $T_2 = 2\pi d\sqrt{\frac{d}{\gamma(m+M)}}$

d) $T_1 = \frac{\pi d}{2}\sqrt{\frac{dM}{\gamma(m+M)^2}}$, $T_2 = \frac{\pi d}{2}\sqrt{\frac{dm}{\gamma(m+M)^2}}$

e) $T_1 = 2\pi d\sqrt{\frac{d(m+M)}{\gamma Mm}}$, $T_2 = 2\pi d\sqrt{\frac{d(m+M)}{\gamma Mm}}$

12. Water is forced out of a fire extinguisher by air pressure, as shown in Fig. t-12. How much gauge air pressure in the tank is required for the water jet to have a speed of 30m/s when the water level is 0.5m below the nozzle?

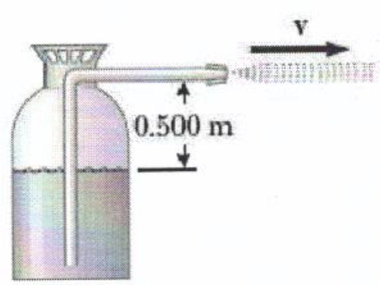

Figure t-12.

a) $p = p_0 + \frac{1}{2}\rho v^2 + mgh$

b) $p = \frac{1}{2}\rho v^2 + mgh$

c) $p = p_0 + \frac{1}{2}\rho v^2$

d) $p = p_0 + \rho v^2 + mgh$

e) $p = mgh$

13. A cube of ice (ρ_i = 917 kg/m^3) whose edge measures 20mm is floating in a glass of ice-cold water with one of its faces parallel to the water's surface. Ice-cold ethyl alcohol (ρ_a = 800 kg/m^3) is gently poured onto the water's surface to form a layer 5mm thick above the water. The alcohol does not mix with the water. When the ice cube again attains hydrostatic equilibrium, what is the distance from the top of the water to the bottom face of the block? Additional cold ethyl alcohol is poured onto the water's surface until the top surface of the alcohol coincides with the top surface of the ice cube (in hydrostatic equilibrium). How thick is the required layer of ethyl alcohol?

a) (14.3 i 5.2) mm

b) (12.1 i 9) mm

c) (13.6 i 8.3) mm

d) (14.3 i 8.3) mm

e) (10.1 i 14.6) mm

14. A wave pulse traveling along a string of linear mass density μ and tension F is described by the relationship:

$$y = A_0 e^{-bx} \sin(kx - \omega t)$$

where the fraction before sine function is said to be the amplitude. What is the power carried by this wave at a point x?

a) $P(x) = \frac{1}{2}\sqrt{F\mu}A_0^2 \exp(-2bx)\omega^2$

b) $P(x) = \sqrt{F/\mu}A_0^2 \exp(-2bx)\omega^2$

c) $P(x)=\frac{1}{2}\sqrt{F/\mu}A_0^2\exp(-bx)\omega^2$

d) $P(x)=\sqrt{F\mu}A_0^2\exp(-4bx)\omega$

e) $P(x)=\frac{1}{2}\sqrt{F\mu}A_0\exp(-2bx)\omega^2$

15. The water streams through the canal with constant speed *v*. Two separated sound wave receives are placed in the canal on the same depth, in the direction of the water flow. A sound wave source with frequency *f* is placed between the receivers, in the same line. The sound speed in the water is *c*. Find the wavelengths of the sound waves registered by the receivers.

a) $\lambda_1=\lambda_2=\frac{c}{f}$

b) $\lambda_1=\frac{c+v}{f}$, $\lambda_2=\frac{c-v}{f}$

c) $\lambda_1=\frac{c-v}{f}$, $\lambda_2=\frac{c+v}{f}$

d) $\lambda_1=\frac{c^2}{f(c+v)}$, $\lambda_2=\frac{c^2}{f(c-v)}$

e) $\lambda_1=\frac{c^2}{f(c-v)}$, $\lambda_2=\frac{c^2}{f(c+v)}$

16. Twenty particles each of mass *m* and confined to a volume *V*, have various speeds: two have speed *v*, three have speed 2*v*, five have speed 3*v*, four have speed 4*v*, three have speed 5*v*, two have speed 6*v*, and one has speed 7*v*. Find the average kinetic energy per particle and the pressure that the particles exert on the walls of the vessel.

a) $\langle E_k\rangle=7.98mv^2$, $\langle p\rangle=99.8\frac{mv^2}{V}$

b) $\langle E_k\rangle=8.79mv^2$, $\langle p\rangle=50.6\frac{mv^2}{V}$

c) $\langle E_k\rangle=9mv^2$, $\langle p\rangle=106\frac{mv^2}{V}$

d) $\langle E_k \rangle = 3.46mv^2$
$\langle p \rangle = 45.78\frac{mv^2}{V}$

e) $\langle E_k \rangle = 7.98mv^2$
$\langle p \rangle = 106.3\frac{mv^2}{V}$

17. The temperature at the surface of the Sun is approximately 5700K, and the temperature at the surface of the Earth is approximately 290K. What entropy change occurs when 1000J of energy is transferred by radiation from the Sun to the Earth?

a) $\Delta S = -3.27J/K$
b) $\Delta S = 32.7J/K$
c) $\Delta S = 4.33J/K$
d) $\Delta S = 2.23J/K$
e) $\Delta S = 3.27J/K$

18. A transparent cylinder of radius *R* = 2m has a mirrored surface on its right half of envelope. A horizontal light ray traveling in air is incident on the left side of the cylinder envelope. The incident light ray and exiting light ray are parallel to each other. Determine the index of refraction of the cylinder material.

a) n = 3
b) n = 1.5
c) n = 2
d) n = 4
e) n = 1.33

19. If the light strikes the single slit at an angle *β* from the perpendicular direction what would the condition for destructive interference on the far away screen be? The distance between the slit and the screen is *a*, and incident light wavelength is *λ*.

a) $\sin\theta = \frac{m\lambda}{d} + \sin\beta$
b) $\sin(\theta - \beta) = \frac{m\lambda}{d}$
c) $\sin(\theta + \beta) = \frac{m\lambda}{d}$
d) $\sin\theta = \frac{m\lambda}{d} - \sin\beta$
e) $\sin\theta = \frac{m\lambda}{2d} - \sin\beta$

20. Light of wavelength 500nm is incident on sodium, with work function 2.28eV. What is the maximum kinetic energy of the ejected photoelectrons?

a) 0.03 eV

b) 0.2 eV

c) 0.6 eV

d) 1.3 eV

e) 2 eV