DEGREE IN COMPUTER ENGINEERING

PHYSICS

EXERCISES CH 1

Review of kinematics and dynamics.

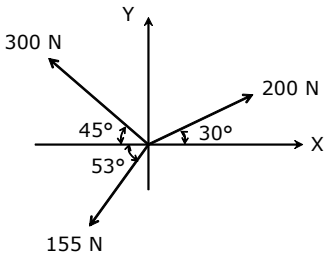
1. An object accelerates when a uniform force of magnitude F_0 is applied to it. The magnitude of the acceleration is 3 m/s^2.

a) Find the new acceleration if the force is increased by two.

b) A second object accelerates at 9 m/s^2 under the influence of the force F_0. Find the ratio between the masses of the two.

c) Find the acceleration produced by F_0 if the objects are tied up together.

2. A particle of mass 200 g is under the action of the forces drawn in the two-dimensional figure attached. Find the magnitude of the acceleration of the particle.



3. A block of mass 160 g is at rest on a horizontal surface (X axis). The block starts to move due to the action of a force given by $\vec{F} = 0.3\,\vec{i}$ [N]. The force stops 2 s after the beginning of the motion, and it is applied again at t=5 s. Find the distance travelled by the object and its velocity 7 s after the beginning of the motion.

4. A bullet of mass 1.8 g travelling at 360 m/s strikes a wooden block and penetrates a distance of 11 cm before stopping.

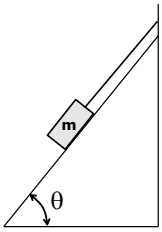
a) Estimate the magnitude of the acceleration and force over the object, assuming the force to be constant (*effects due to gravity can be neglected*).

b) How long does it take for the bullet to stop?

5. Sallyanne throws a ball into the air with an initial speed of 50 m/s at an angle 37º above the horizontal. Find how long the ball is in the air, and how far does it travel.

6. A ball *A* is thrown upwards with an initial speed of 10 m/s. 1 s later, a second ball *B* is thrown upwards with the same speed. Find (a) the height at which they meet and (b) the velocity of each of the balls when they meet.

7. A box is held in position by a cable along a frictionless incline. If θ = 60° and m = 50 kg, find the tension in the cable and the normal force exerted by the incline.



8. A block is pushed up a 20° inclined plane with an initial speed of 5 m/s and immediately released. What is the distance traveled by the block before stopping, considering that the frictional force is neglected?

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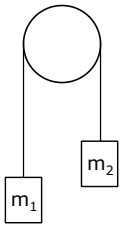
9. Assuming a frictionless pulley and a massless string, calculate the magnitudes of the tension of the string and the acceleration of either block for the system in the figure, being their masses m_1 = 3 kg and m_2 = 5 kg.



10. A block of mass 5 kg is attached to a cord of length L=1 m, which is fixed at one end. The block moves in a horizontal circle on a frictionless table. If the frequency of motion is f= 0.25 Hz, find the tension in the cord.

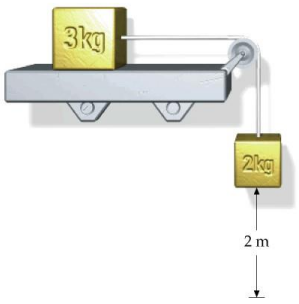
11. A 3 kg block slides along a frictionless horizontal surface with a speed of 7 m/s. After sliding a distance of 2 m, the block makes a smooth transition to a frictionless ramp inclined an angle θ with respect to the horizontal. Find θ, knowing that the block slides up 3.89 m before coming momentarily to rest.

12. A 2 kg block is released from the top side of a 6 m long frictionless ramp inclined at an angle of 30º with the horizontal. After sliding along the ramp, the block moves a distance D along a rough horizontal surface. Find:

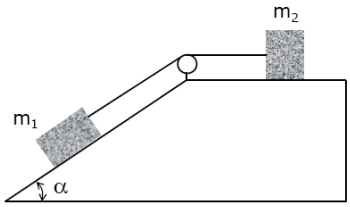
a) The speed of the block when it reaches the end of the ramp.

b) The distance D, knowing that the magnitude of the frictional force on the horizontal surface is 6.53 N.

13. A 3 kg box moves on a horizontal shelf attached to a 2 kg box by a light string as shown in the figure. If the system starts from rest, and the coefficient of kinetic friction between the box and the shelf is 0.3, find the time for the 2 kg box to fall 2 m to the floor.



14. Two objects with masses m_1 = 3kg and m_2 = 4 kg are connected by a massless rope (see figure). The system moves with an acceleration of magnitude 1.8 m/s^2. (a) Find the angle α supposing that friction can be neglected. (b) Find the acceleration of the system if the coefficient of kinetic friction is 0.1.



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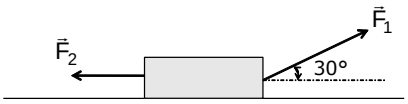
15. The force $\vec{F} = a x^3 \, \vec{i}$, being a = 5 N/m^3, acts on an object that moves along the X axis. Find the work done by this force when the object moves from A (1,0) to B (2,0) (these coordinates are expressed in m).

16. The figure shows a 40 kg block pulled by two forces of magnitudes F_1 = 130 N and F_2 = 40 N. The block travels a distance of 20 m on the horizontal surface. Find:



a) The work done by $\vec{F}_1$ and $\vec{F}_2$.

b) The work done by the weight.

c) The work done by the normal force.

d) The total work done.

e) The speed after sliding 20 m if the block starts from rest.

17. Julia pushes up her 20 kg bag along a ramp inclined 25º with respect to the horizontal by applying a uniform force of magnitude 145 N in the direction parallel to the ramp. She moves the bag 4.6 m along the ramp.

a) Find the total work done on the bag.

b) Find the speed after the 4.6 m if the bag starts from rest.

Neglect friction.

18. The novel rotor design for a helicopter has four blades; each of them is 3.2 m long. The helicopter is tested in a wind tunnel, rotating at 600 rpm. (a) What is the linear speed of the tip of one of the blades? (b) Find the radial acceleration of the blade tip expressed as a multiple of g.

19. An object of mass 250 g describes a circle of radius 4m. The speed of the object is 20 m/s.

a) Calculate the magnitude of the centripetal force.

b) Calculate the work done by the centripetal force when the object has traveled a quarter of the total length of the circumference.

20. A crane (see figure) is used to lift a 120 kg box to a height of 15 m at a constant speed of 1.25 m/s. Find the power developed and the work done by the crane.

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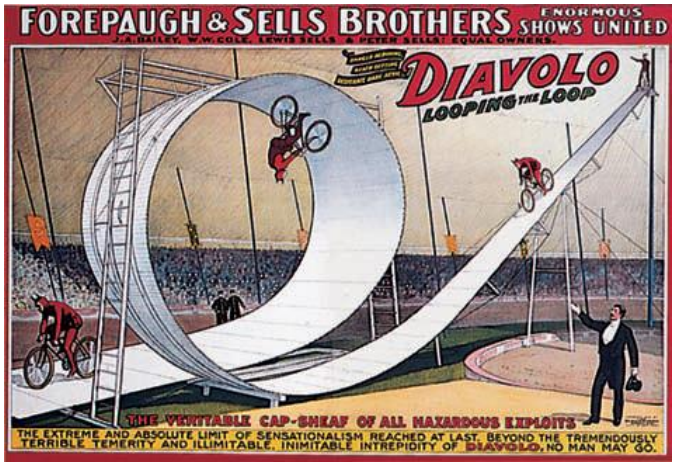
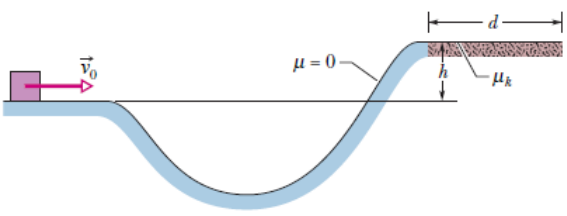
21. A rock is shot vertically upward from the edge of the top of a tall building. The rock reaches its maximum height above the top of the building t_0=1.60 s after being shot. Then, after barely missing the edge of the building as it falls downward, the rock strikes the ground t_f=6.00 s after it is launched. In SI units: (a) with what upward velocity ($\mathbf{v_{in}}$) is the rock shot, (b) how tall (d) is the building?

22. "Top gun" pilots have long worried about taking a turn too tightly. As a pilot's body undergoes centripetal acceleration, with the head toward the center of curvature, the blood pressure in the brain decreases, leading to loss of brain function. There are several warning signs. When the centripetal acceleration is 2*g* or 3*g*, the pilot feels heavy. At about 4*g*, the pilot's vision switches to black and white and narrows to "tunnel vision." If that acceleration is sustained or increased, vision ceases and, soon after, the pilot is unconscious, a condition known as *g*-LOC for "*g*-induced loss of consciousness."
What is the magnitude of the acceleration, in *g* units, of a pilot whose aircraft enters a horizontal circular turn with a velocity of (400**i**, 500**j**) m/s and 24.0 s later leaves the turn with a velocity of (-400**i**, -500**j**) m/s?

23. In a 1901 circus performance, Allo "Dare Devil" Diavolo introduced the stunt of riding a bicycle in a loop-the-loop. Assuming that the loop is a circle with radius *R*=2.7 m, what is the least speed *v* that Diavolo and his bicycle could have at the top of the loop to remain in contact with it there?



24. A block slides along a track from one level to a higher level after passing through an intermediate valley. The track is frictionless until the block reaches the higher level. There a frictional force stops the block in a distance *d*. The block's initial speed is v_0, the height difference is *h*, and the friction coefficient is μ_k. Find *d*.



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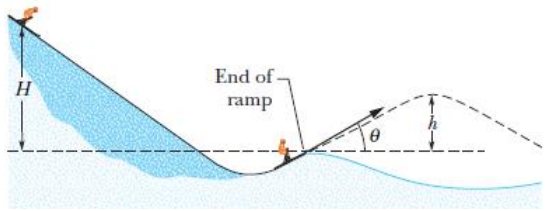
25. A skier of mass *m* starts from rest at height *H* above the end of a ski-jump ramp and leaves the ramp at angle θ. Neglect the effects of air resistance and assume the ramp is frictionless. *m*, *H* and *θ* are known. (a) What is the maximum height *h* of his jump above the end of the ramp? (b) If he increased his weight by putting on a backpack, would *h* then be greater, less, or the same?



ANSWERS

1. a) $a_2 = 6\ m/s^2$
b) $m_1 = 3m_2$
c) $a = 2.25\ m/s^2$

2. $a = 1150.6\ m/s^2$

3. d = 26.3 m v = 7.5 m/s

4. a) F = 1060.36 N $a = 5.9\times10^5\ m/s^2$
b) $t = 6.11\times10^{-4}$ s

5. t=6.13 s x= 245 m

6. (a) y = 3.88 m (b) $\vec{v}_A = -4.9\vec{j}$ m/s , $\vec{v}_B = 4.9\vec{j}$ m/s

7. T = 424.35 N N = 245 N

8. 3.73 m

9. a) T = 36.75 N b) a = 2.45 m/s^2

10. F_T = 12.34 N

11. θ = 40°

12. a) v = 7.67 m/s b) D = 9 m

13. t=1.3 s

14. (a) α = 25.4º (b) a = 0.86 m/s^2

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15. W = 18.75 J

16. a) W_1 = 2252 J W_2 = -800 J
b) W = 0
c) W = 0
d) W_T = 1452 J
e) v = 8.5 m/s

17. a) W_T = 286 J b) v = 5.3 m/s

18. a) v = 201.1 m/s b) a_c = 1289 g

19. a) F_c = 25 N b) W = 0

20. a) P = 1470 W b) W = 17.64 kJ

21. a) 15.7 m/s b) 82.3 m

22. γ=8.5g

23. v=5.1 m/s

24. $d= v_0^2/2\mu g - h/\mu$

25. $h=H\sin^2\theta$