Group Number		Name		Type
List Number		Surname		A
Student ID		Signature		
e-mail				

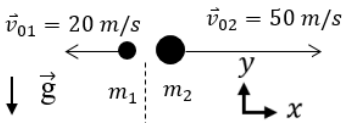
ATTENTION: There is normally only one correct answer for each question and each correct answer is equal to 1 point. Only the answers on your answer sheet form will be evaluated. Please be sure that you have marked all of your answers on the answer sheet form by using a pencil (*not* pen).

1. The fluid resistance acting on a mass m released into a liquid is given as $F = kv$ in Newtons where k is a constant, v is the velocity of the object. The buoyant force acting on this object is given as $f = A\rho g$, where A is the volume of the object, g is the gravitational acceleration and ρ is the density of the liquid. Accordingly, which of the following equations is an expression obtained from Newton's 2nd law? (buoyant force: [TR] kaldırma kuvveti)

(a) $\frac{d^2x}{dt^2} = \frac{k}{m}\frac{dx}{dt} + g\left(1 + \frac{\rho A}{m}\right)$
(b) $\frac{d^2x}{dt^2} = \frac{k}{m}\frac{dx}{dt} - g\left(1 - \frac{\rho A}{m}\right)$
(c) $\frac{d^2x}{dt^2} = -\frac{k}{m}\frac{dx}{dt} + g\left(1 + \frac{\rho A}{m}\right)$
(d) $\frac{d^2x}{dt^2} = -\frac{k}{m}\frac{dx}{dt} + g\left(1 - \frac{\rho A}{m}\right)$
(e) $\frac{d^2x}{dt^2} = -\frac{k}{m}\frac{dx}{dt} - g\left(1 - \frac{\rho A}{m}\right)$

Questions 2-5

As shown in the figure, the masses m_1 and m_2 are thrown from a high location, parallel to the ground and in opposite directions, at speeds of $v_{01} = 20$ m/s and $v_{02} = 50$ m/s. Neglect the air friction and take $g = 10$ m/s^2.



2. In which of the following option are the velocities of the masses at $t = 3$ s correctly given?

(a) $\vec{v}_1 = 20\hat{\imath} - 30\hat{\jmath}$; $\vec{v}_2 = 40\hat{\imath} - 30\hat{\jmath}$ (b) $\vec{v}_1 = -20\hat{\imath} - 30\hat{\jmath}$; $\vec{v}_2 = 50\hat{\imath} - 30\hat{\jmath}$ (c) $\vec{v}_1 = -10\hat{\imath} - 30\hat{\jmath}$; $\vec{v}_2 = 30\hat{\imath} - 30\hat{\jmath}$
(d) $\vec{v}_1 = -20\hat{\imath} - 30\hat{\jmath}$; $\vec{v}_2 = -30\hat{\imath} - 30\hat{\jmath}$ (e) $\vec{v}_1 = 10\hat{\imath} - 30\hat{\jmath}$; $\vec{v}_2 = 30\hat{\imath} - 30\hat{\jmath}$

3. What is the distance between the masses in unit of meters at $t = 3$ s?

(a) 150 (b) 250 (c) 180 (d) 210 (e) 230

4. What is the velocity of mass m_1 with respect to mass m_2 at $t = 3$ s?

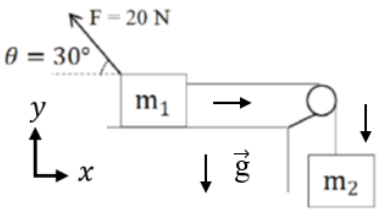
(a) $-80\hat{\imath}$ m/s (b) $-60\hat{\imath}$ m/s (c) $80\hat{\imath}$ m/s (d) $-70\hat{\imath}$ m/s (e) $75\hat{\imath}$ m/s

5. At which instant t are the velocities of masses perpendicular to each other?

(a) $\sqrt{7}$ s (b) 4 s (c) $\sqrt{12}$ s (d) 3 s (e) $\sqrt{10}$ s

Questions 6-9

Two masses $m_1 = 2.0$ kg and $m_2 = 3.0$ kg are connected by a massless string passing over a massless and frictionless pulley. Mass m_1 moves on a horizontal surface having a coefficient of kinetic friction $\mu_k = 0.50$ and is subject to a force $F = 20.0$ N. ($\cos 30° = 0.9$, $\sin 30° = 0.5$, $g = 10$ m/s^2)



6. What is the magnitude of the acceleration of m_2?
(a) 0.7 m/s^2 (b) 1.4 m/s^2 (c) 2.4 m/s^2 (d) 0.8 m/s^2 (e) 1.8 m/s^2

7. What is the tension on the string?
(a) 25.8 N (b) 15.6 N (c) 20.0 N (d) 21.4 N (e) 18.0 N

8. What is the magnitude of the frictional force on m_1?
(a) 4.0 N (b) 7.0 N (c) 5.0 N (d) 3.0 N (e) 8.0 N

9. What should be the mass m_1 if the two masses move with a constant speed?
(a) 2.6 kg (b) 4.0 kg (c) 3.4 kg (d) 1.8 kg (e) 2.0 kg

Questions 10-11

A small block of mass $m = 0.5$ kg sits 2.25 m from the center of a horizontal turntable whose frequency of rotation is f and the coefficient of static friction between the block and the turntable is $\mu_s = 0.9$. Take $g = 10$ m/s^2, $\pi \approx 3$.

10. What is the maximum value of f to keep the block at rest with respect to the turntable?
(a) $\frac{2}{3}$ Hz (b) $\frac{1}{5}$ Hz (c) 2.0 Hz (d) $\frac{1}{3}$ Hz (e) 1.0 Hz

11. If $f = 0.25$ Hz, what is the magnitude of the friction?
(a) $\frac{93}{17}$ N (b) $\frac{81}{32}$ N (c) $\frac{76}{35}$ N (d) $\frac{49}{14}$ N (e) $\frac{41}{17}$ N

Questions 12-13

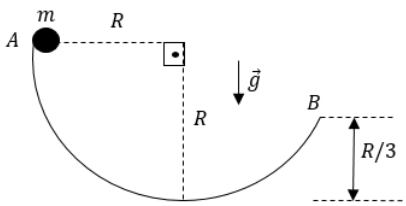
A small puck of mass $m = 0.3$ kg moves in a circle of radius $R = 1.5$ m on a table; the puck is tied with a massless string to a pin at the center of the circular path. The coefficient of kinetic friction between the puck and the table is $\mu_k = 0.2$. At $t = 0$, the puck starts rotating with an initial speed $v_0 = 10$ m/s. Take $g = 10$ m/s^2, $\pi \approx 3$.

12. What is the tension in the string at $t = 0$?
(a) 20 N (b) 10 N (c) 15 N (d) 30 N (e) 25 N

13. What is the tension in the string at the end of one revolution?
(a) 14.6 N (b) 10.6 N (c) 12.8 N (d) 11.0 N (e) 15.2 N

Questions 14-15

A block of mass m slides on a frictionless loop-to-loop track of radius R, as shown in the figure. The block starts from rest at point A.



14. What is the speed of the block at point B?
(a) $\sqrt{\frac{5gR}{2}}$ (b) $\sqrt{\frac{4gR}{3}}$ (c) $\sqrt{\frac{3gR}{5}}$ (d) $\sqrt{\frac{7gR}{3}}$ (e) $\sqrt{\frac{8gR}{5}}$

15. What is the magnitude of the normal force at point B?
(a) $1.5mg$ (b) $2.5mg$ (c) $2mg$ (d) mg (e) $3mg$

Questions 16-17

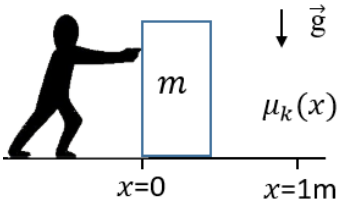
A net force $\vec{F} = (4x - 3x^2)\hat{i}$ acts on a particle as the particle of mass m moves along the x-axis, with $\vec{F}$ in newtons, x in meters.

16. What is the work done by the net force in moving the particle from the origin $x = 0$ to $x = 3$ m?
(a) -7 J (b) 6 J (c) 8 J (d) -8 J (e) -9 J

17. At $x = 0$ the particle's speed is $\sqrt{10}$ m/s, at $x = 3$ m, its kinetic energy is 11 J. Find the mass of the particle.
(a) 4 kg (b) 2 kg (c) 5 kg (d) 3 kg (e) 6 kg

Questions 18-20

A worker pushes a 20-kg crate straight across a 1-m-long section of horizontal floor with a constant force of $F = 20$ N. This section of the floor has the peculiarity that it becomes rougher from beginning to end, and the crate is moving at 2 m/s when it arrives at the start of this section. The coefficient of friction is 0.15 at the start and 0.25 at the finish, varying linearly with distance in between. ($g = 10$ m/s^2)



18. What is the coefficient of kinetic friction as a function of distance x?
(a) $\mu_k(x) = 0.15 + 0.10x$ (b) $\mu_k(x) = 0.15 + 0.25x$ (c) $\mu_k(x) = 0.15 + 0.15x$
(d) $\mu_k(x) = 0.20 + 0.10x$ (e) $\mu_k(x) = 0.10 + 0.25x$

19. What is the work done by the net force acting on the block?
(a) -17 J (b) 25 J (c) 17 J (d) -15 J (e) -20 J

20. What is the speed of the crate at the end of the section?
(a) $\sqrt{5}$ m/s (b) $\sqrt{3}$ m/s (c) 2 m/s (d) 3 m/s (e) $\sqrt{2}$ m/s