

Instructions: You have a total of 50 minutes to complete this test.

Answer each question completely showing complete details.

For complete credit you must include correct SI units with numerical answers.

Time Start _____ Time finish _____ pledged _____

Constants: $g = 9.8 \frac{\text{m}}{\text{s}^2}$

[1] A mass m is placed on a spring of spring constant k and the spring is compressed through a distance x . The spring is then released. After the mass leaves the spring, it slides along a flat surface with a coefficient of friction μ (assume that it only encounters friction after leaving the spring).

(a) in the box shown, draw and correctly label an appropriate free body diagram for the sliding mass (after leaving the spring)



(b) With what speed will the mass leave the spring in terms of m , k and x ?

(c) suppose that instead of sliding on a flat surface, the mass rose up an inclined plane of angle θ (you may now assume that this system is frictionless). How high above the initial level will the mass rise in terms of k , x and m ?

(d) provide numerical solutions with correct SI units for the case $k=10 \text{ N/m}$, $m=2 \text{ kg}$, and $x=.5 \text{ m}$ and $\mu=0.5$.

d:b _____

d:c _____

[2] Mass m_1 traveling at a velocity v collides and sticks to a mass m_2 which is initially at rest. The pair then slide across a flat surface which is frictionless.

(a) What is the velocity of the pair right after the collision in terms of m_1 , m_2 , and v ?

(b) The mass pair then encounters a spring of spring constant k . How much does the spring compress until the mass pair stops in terms of m_1 , m_2 , k and v ?

(c) If the original collision were completely elastic and m_2 was $1/2 m_1$, with what velocity would m_2 move after the collision in terms of v only?

(d) provide numerical solutions with correct SI units for the case $m_1 = 1$ kg, $m_2 = 0.5$ kg, $\mu = 0.6$, $v = 2$ m/s and $k = 5$ N/m.

d:a _____

d:b _____

d:c _____

[3] A mass m is attached to a string of radius R and swung in a planar circle and thus travels through a distance of $2\pi R$ in each revolution. It is observed that the time it takes for the mass to go around the circle is T . You may assume this undergoes uniform circular motion.

(a) what is the tangential velocity, v , of the mass in terms of R and T ?

(b) What is the angular velocity, ω , of the mass in terms of R and T ?

(c) What is the centripetal acceleration of the mass in terms of R and T ?

(d) What is the centripetal force acting on the mass in terms of m , R and T ?

(e) For the case $m=2$ kg, $R=1$ m, and $T=1$ s, provide numerical answers with correct SI units.

e: a _____

e: b _____

e: c _____

e: d _____

[4] A point on a wheel of radius R is observed to rotate according to $\theta = \theta_0 + \omega_0 t + \frac{1}{2} c t^2$ where c has SI units of “rad”/s³.

(a) at a time t , what is the angular velocity of the point?

(b) at a time t , what is the angular acceleration of the point?

(c) At a time t , what is the tangential acceleration of the point on the wheel?

(d) At a time t , what is the centripetal acceleration of the point on the wheel if $\omega_0 = 0$?

(e) Provide numerical answer for the case $R=1$ m, $\theta_0=0$, $\omega_0=0$, $c=2$ “rad”/s² and $t=3$ s.

e:a _____ **e:b** _____ **e:c** _____ **e:d** _____

(f) What is the total acceleration at this time?