Physics 2101, Exam #2, Fall 2009

September 29, 2009

Name: SOLUTIONS

ID#:____________________

Section: (Circle one)

1 (Chastain, MWF 8:40 AM)

2 (Chastain, MWF 10:40 AM)

3 (Rupnik, MWF 12:40 PM)

4 (Plummer, TTh 9:10)

5 (Adams, TTh 12:10)

- Please be sure to write (print) your name and circle your section above.
- Please turn OFF your cell phone and MP3 player!
- Feel free to detach, use, and keep the formula sheet. No other reference material is allowed during the exam.
- You may use either a scientific or a graphing calculator...
- GOOD LUCK!

1. (10pts) A constant force of $\vec{F}$ acts on a 5 kg object that moves from the origin to a final position $\vec{d}_f = 3\hat{j}$. The force is in units of newtons and the positions are measured in meters. If the work done by the force is -60 J, then what is the y-component of $\vec{F}$?

(a) -1 N
(b) -10 N
(c) -20 N
(d) +20 N
(e) +60 N

WORK = $\int \vec{F} \cdot \delta\vec{r} = F_y(d_f - d_i) = F_y(3) = -60$

$F_y = -20N$

2. (5pts) A 3 kg object is moving at a speed of 15 m/s. What is the maximum instantaneous power that can be delivered to the object by a 30 N applied force?

(a) zero
(b) 9.8 W
(c) 30 W
(d) 100 W
(e) 450 W

$P_{INST.}$ $\vec{F} \cdot \vec{V} = 30N \cdot 15 \frac{m}{sec} = 450$ W

3. (10pts) A 2 kg block of clay is sent sliding across a ice skating rink floor at 6 m/s. It collides and sticks to a second bock of clay that is initially at rest. The two block then moves as one with a speed of 2 m/s. What is the mass of the second block of clay? (neglect friction)

CONSERVATION of MOMENTUM

(a) 2 kg
(b) 4 kg
(c) 6 kg
(d) 8 kg
(e) none of the above

m_0 $\vec{V_0}$ = m_0 M_1 $\vec{V_1}$

$2kg \cdot 6 \frac{m}{sec} = (2 + M_1)\, 2$

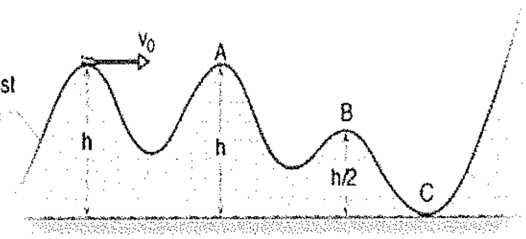
$M_1 = 4Kg$

4. (5pts) Which one of the following is *not* a property of energy?

(a) Energy has units of Joules.
(b) Energy cannot be created nor destroyed.
(c) Potential energy can be positive or negative.
(d) Kinetic energy must always be positive.
(e) Energy is vector quantity.

5. (*Show your work for this problem.*) In the figure below a frictionless roller coaster of mass 1000 kg tops the first hill at 10 m/s, the height is h = 64 m.

A) (5pts) Taking point C to be zero potential energy, what are the kinetic and potential energies of the roller coaster at point A?



$KE = \frac{1}{2}mv^2 = \frac{1}{2}(1000)100 = 5 \times 10^4 J$

$POT = U_g = mgh = (1000)(9.8)64$

$POT = U_g = 6.27 \times 10^5 J$

B) (10pts) What is the speed of the roller coaster at point B?

$E_{mech} = KE + U_g = 6.77 \times 10^5$

at B

$KE + mg\frac{h}{2} = 6.77 \times 10^5$

$\frac{1}{2}mv^2 = 6.77 \times 10^5 - 3.136 \times 10^5$

$V = 26.9 \frac{m}{sec}$

6. (10pts) A 3 kg mass is connected to a spring with k = 200 N/m, as shown below. The mass is pulled to the right a distance x = 0.2 m and then released from rest. What is the total mechanical energy of the spring-mass system when the mass reaches x = 0.1 m.

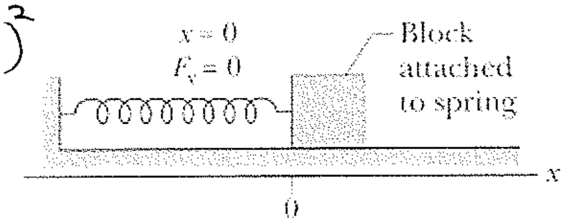
(a) zero
~~(b) 1 J~~
(c) 4 J
~~(d) 7 J~~
(e) 9.8 J

$E_{mech} = KE + \frac{1}{2}kd^2$

$= 0 + \frac{1}{2}(200)(0.2)^2$

$E_{mech} = 4 J$

conserved

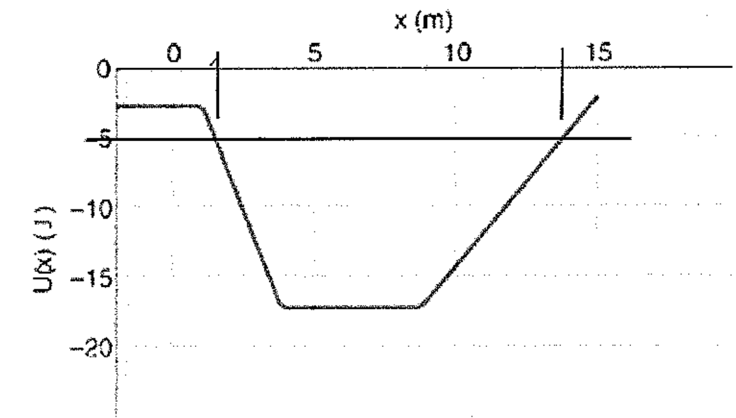


7. (5pts) If the sum of external forces acting on a system of particles is zero, then which of the following statements must be true?

(a) There can be no internal forces between the particles in the system.
(b) The total momentum of the system must be zero.
(c) The total energy of the system must be zero.
(d) All of the particles in the system will be in static equilibrium.
(e) The total momentum of the system must be a constant.

8. (10pts) A conservative force acts a particle that moves along the x-axis. The potential energy *U(x)* associated with the force is depicted in the plot shown below. If the mechanical energy of the mass is -5 J, then what are the approximate limits of the x-axis motion?

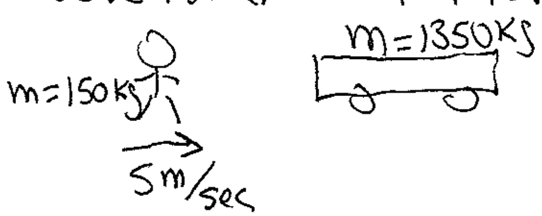
(a) x_{min} = -2 m; x_{max} = 15 m
(b) x_{min} = 0 m; x_{max} = 15 m
(c) x_{min} = 4 m; x_{max} = 9 m
(d) x_{min} = 1.5 m; x_{max} = 9 m
(e) x_{min} = 1.5 m; x_{max} = 14 m



9. (10pts) A 1350 kg railroad flatcar, which can move with negligible friction, is at rest next to a platform. A 150 kg defensive lineman runs at 5.0 m/s along the platform (parallel to the track) and then jumps onto the flatcar. What is the speed of the flatcar after he lands on it?

CONSERVATION of MOMENTUM

(a) 0.50 m/s
(b) 0.55 m/s
(c) 0.72 m/s
(d) 0.98 m/s
(e) 1.3 m/s



$(150)(5) = (150 + 1350)V$

$V = 0.5$ m/sec

10. (*Show your work on this problem*) In the figure below, a small block of mass $m = 2$ kg can slide along the frictionless loop-the-loop, with loop radius R = 0.1 m. The block is released from rest at point *P*, at height $h = 0.5$ m above the bottom of the loop.

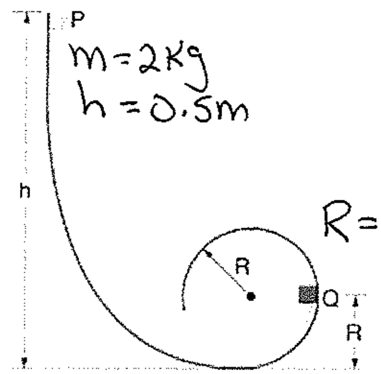
E_{mech} (conserved) $= mgh = 9.8$ J

AT Q

$E_{mech} = 9.8 = \frac{1}{2}mv^2 + mgR$

$\frac{1}{2}mv^2 = 7.84$

$V = 2.8 \frac{m}{se}$



R=0.1

A) (5pts) What is the centripetal acceleration of the block at the point Q?

AT Q = $a_c = \frac{V^2}{r} = 78.4 \frac{m}{sec^2}$

B) (5pts) What is the *mechanical energy* of the block at the point Q?

See ABOVE

$E_{mech} = 9.8$ J

C) (10pts) Now suppose that the original track is replaced with one that has friction. If the block just makes it to point Q before momentarily coming to rest, then what is the work done by friction in going from P to Q?

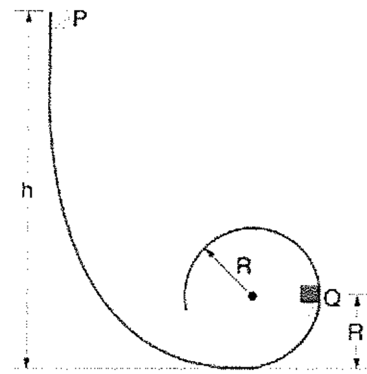
$E_{mech} = E_{KE} + mgR + E_{thermal}$

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ ||

$\quad\quad\quad\quad\quad\quad\quad\quad$ − WORK done By FRICTION

$W_f = (9.8 - 1.96) = -7.84$

10. (*Show your work on this problem*) In the figure below, a small block of mass $m = 2$ kg can slide along the frictionless loop-the-loop, with loop radius R = 0.1 m. The block is released from rest at point *P*, at height $h = 0.5$ m above the bottom of the loop.



A) (5pts) What is the centripetal acceleration of the block at the point Q?

B) (5pts) What is the *mechanical energy* of the block at the point Q?

C) (10pts) Now suppose that the original track is replaced with one that has friction. If the block just makes it to point Q before momentarily coming to rest, then what is the work done by friction in going from P to Q?