Kuwait University Physics Department

Physics 101
Final Examination

January 16, 2003

Name: Solutions Student No. .....

Instructors: Drs. A. Al-Jassar, Hala Al-Jassar, A. Al-Yassin, A. Behbehani, F. El-Akkad, I. El-Sabbah, M. Fahmy, Y. Makdisi

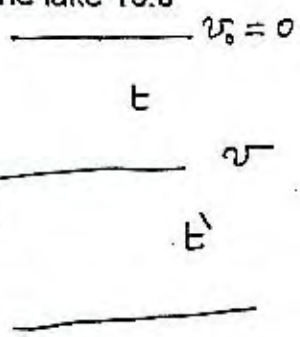
For use by Instructors only

Prob.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Marks													

1. Answer all the questions.
2. The solution should be given explicitly for each problem.
3. No solution = no grade.
4. Check the correct answer for each question.
5. Take g = 10 m/s^2.

NOTE: IT IS STRICTLY FORBIDDEN TO BRING ANY MOBILE COMMUNICATION DEVICES (MOBILE PHONES, PAGERS, ETC.), INTO THE EXAMINATION HALL.

1-A heavy ball is dropped into a lake from a height of 30.0 m above the water. It hits the water with a certain velocity and continues to sink to the bottom of the lake at this same constant velocity. It reaches the bottom of the lake 10.0 s after it was dropped. How deep is the lake (in m)?



known $v_0, g, \Delta y$

wanted v

$v^2 = v_0^2 - 2g\Delta y$

$v^2 = -2(10)(-30) \Rightarrow v = 24.5$ m/s

known $v_0, g, \Delta y$.

wanted t

$\Delta y = v_0 t - \frac{1}{2} g t^2 \Rightarrow -30 = -\frac{1}{2}(10) t^2$

$\Rightarrow t = 2.45$ s $\Rightarrow t' = 10 - 2.45 = 7.55$ $\quad h = v t' = 24.5(7.55) = 185$ m

2-A particle starts from the origin at t=0 with velocity of (12i + 16j) m/s and moves in the xy plane with constant acceleration of a = (-2.0i – 4.0j) m/s^2. What is the distance (in m) from the particle to the origin at t= 2.0 s?

a) 18 b) 45 c) 31 d) 40 e) 36 f) other

$$\vec{r} - \vec{r}_0 = \vec{v}_0 t + \frac{1}{2}\vec{a} t^2$$

$$\vec{r} - 0 = (12\hat{i} + 16\hat{j})2 + \frac{1}{2}(-2\hat{i} - 4\hat{j})(2)^2$$

$$\vec{r} = (24 - 4)\hat{i} + (32 - 8)\hat{j}$$

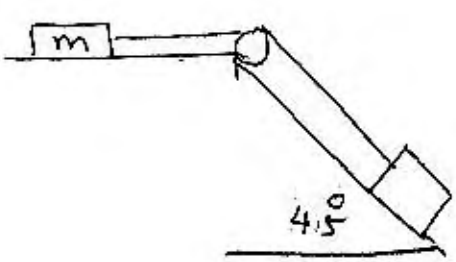
$$= 20\hat{i} - 24\hat{j}$$

$$r = \sqrt{(20)^2 + (24)^2} = 31 \text{ m}$$

3-Find the acceleration of the system if the surface is frictionless. Take M = 7.5 kg, and m = 2.5 kg

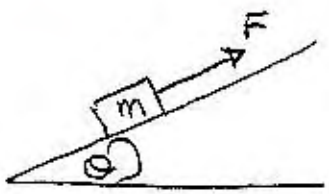
$$a = \frac{mg\sin\theta}{m + M} = \frac{7.5(10)\sin 45}{2.5 + 7.5}$$

$$a = 4.87 \approx 5.3 \text{ m/s}^2$$



parallel to the plane

4- What is the magnitude of the force F (in N) needed to pull a 70 kg-block up a 7° incline (rough) at a constant speed if, in absence of the force F, the block can move down the incline at constant speed?



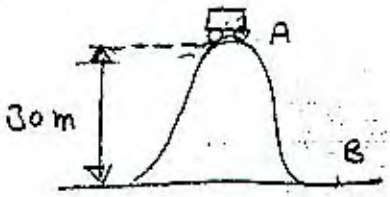
down $f_k = mg\sin\theta$

up $F - mg\sin\theta - f_k = 0$

$F = 2mg\sin\theta$

$= 2(70)(10)\sin 7 = 170.6 \simeq 171\ N$

5-The roller coaster in the figure passes point A with a speed of 1.2 m/s. If the average force of friction is equal to one-fifth of its weight, with what speed will it reach point B? The distance traveled is 67.0 m.



$W_{net} = \Delta K$

$W_g + W_f = K_f - K_i$

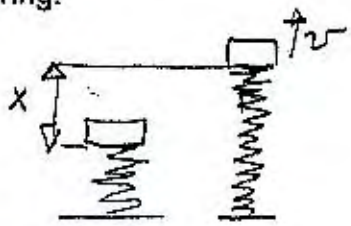
$mgh - f_k d = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$

$mgh + \frac{1}{5}mgd = \frac{1}{2}mv^2 + \frac{1}{2}mv_0^2$

$2g(h - \frac{1}{5}d) = v^2 - (1.2)^2 \Rightarrow 2(10)(30 - \frac{67}{5}) + (1.2)^2 = v^2$

$v = 18.3\ m/s$

6-A 0.30-kg block is placed on a vertical spring (ignore its mass), whose spring constant is 850 N/m. The spring is compressed 0.40 m and then released. Find the speed of the block at the instant it leaves the spring.



$E_i = E_f$

$\frac{1}{2}kx^2 = mgx + \frac{1}{2}mv^2$

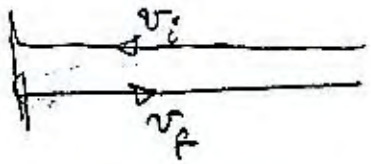
$\frac{1}{2}(850)(0.4)^2 = 0.3(10)(0.4) + \frac{1}{2}(0.3)v^2$

$v = 21\ m/s$

Ch. 9

7-A batter hits a 0.14 kg ball, which is initially traveling at a speed of 40.0 m/s. The ball loses 25% of its kinetic energy during the impact with the bat. What is the impulse (in N.s) of the force that the bat exerts on the ball? The ball is moving along the x-axis.

magnitude



$K_f = 0.75\, K_i$

$\frac{1}{2} m v_f^2 = 0.75 \left(\frac{1}{2} m v_i^2\right)$

$v_f = \sqrt{0.75}\, v_i = \sqrt{0.75}\,(40) = 34.64$ m/s.

$J = \Delta p = m(v_f - v_i) = 0.14\,[34.64 - (-40)]$

$J = 10.4 \simeq 10$ N.s.

1.10

8-A 1.9 kg ball initially traveling with a speed of 2.5 m/s strikes, head-on, a stationary 0.50 kg ball. Knowing that the collision is elastic, determine the final velocity (in m/s) of the 0.50 kg ball.

$$v_f = \frac{2m_1}{m_1 + m_2} v_{1i} = \frac{2(1.9)}{1.9 + 0.5}\, 2.5$$

$$v_f = 3.95 \simeq 4 \text{ m/s}$$

2.5 kg 5-kg

9-A billiard ball moving at a speed of 4 m/s strikes another ball moving in the same direction with a speed of 2 m/s. After collision the 2 kg ball travels in a direction making an angle of 60° with the initial direction. Find the speed of the center of mass of the two balls after collision

CH-9.

$$M v_{CM} = m_1 v_1 + m_2 v_2$$

$$7.5 v_{CM} = 2.5(4) + 5(2)$$

$$v_{CM} = \frac{20}{7.5} = 2.7 \text{ m/s}$$

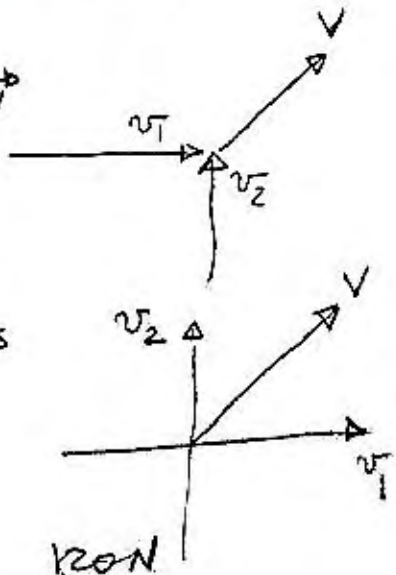
10-A 1500 kg car is traveling east with a speed of 85 km/h when it collides with a 1200 kg car traveling north with a speed of 65 km/h. The cars lock together during the collision. What is the velocity (in m/s) of the cars after the collision?

$$m_1\vec{v}_1 + m_2\vec{v}_2 = (m_1+m_2)\vec{V}$$

$$1500\left(\frac{85}{3.6}\right)\hat{i} + 1200\left(\frac{65}{3.6}\right)\hat{j} = (2700)\vec{V}$$

$$\vec{V} = 13.1\,\hat{i} + 8.0\,\hat{j}$$

$$V = \sqrt{(13.1)^2 + (8)^2} = 15.3\ \text{m/s} \simeq 15\ \text{m}$$



11-A 3.0 m rod with ~~a mass of 2.0 kg~~ is attached to a wall by a rigid support and makes an angle of 20.0° to the horizontal as shown. A 12.0 kg flag is hung so that its weight acts at a point 2.5 m from the support. In order for the rod to be in *equilibrium* an additional force must be supplied perpendicular to the rod. If the magnitude of this force can be at most 175 N at what distance (in m) from the support must it be located?

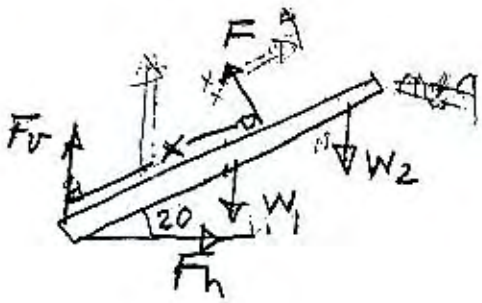
Weight W_1 20 N

120 N

$$\Sigma\tau = W_1 d_1 - W_2 d_2 = 0$$

$$x = \frac{20(1.5)\cos 20 + 120(2.5)\cos 20}{175}$$

$$x = 1.77\ \text{m}$$



12- one end of a string is attached to the rim of a wheel 15 cm in radius. A block hangs from the string as shown. The wheel is given an initial angular velocity anti-clockwise of 9.0 rad /s and then is left to decelerate at a rate of 3.0 rad/s^2. What length (in m) of string will be wrapped around the wheel when it comes momentarily to rest?

$r = 0.15\ \text{m}$ $\omega_0 = 9\ \text{rad/s}$ $\alpha = -3\ \text{rad/s}^2$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$0 = (9)^2 + 2(-3)\Delta\theta$$

$$\Delta\theta = 13.5\ \text{rad}$$

$$S = r\Delta\theta = 0.15(13.5) = 2\ \text{m}$$