PHYS 101 Midterm examination #1 (vers. 1B)

18 Oct., 2002 Name Key

Time: 50 minutes Student No. [redacted]

For questions 2 and 3, please show complete solutions and explain your reasoning, stating any principles that you have used.

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1 (10 marks). For each of the following five questions, please circle one answer only.

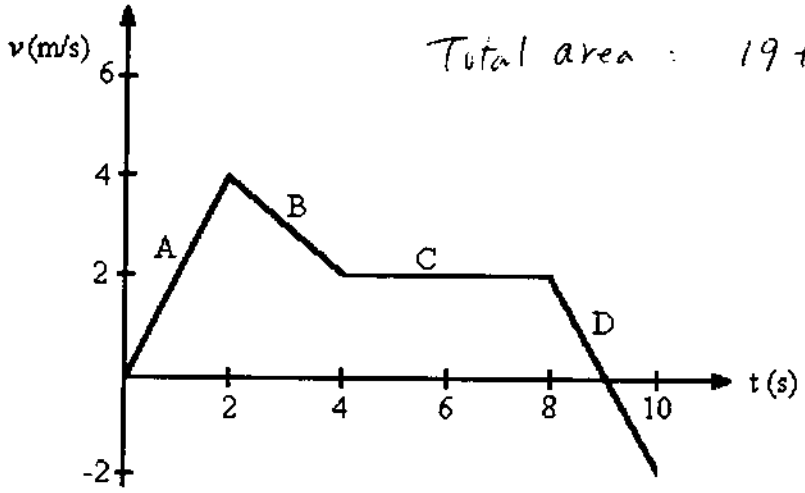
(d) (i) The figure below shows the velocity-versus-time graph for a robot. Find the total distance traveled by the robot for the 10 s shown on the graph.

(a) 4 m
(b) 2 m
(c) 16 m
(d) 20 m
(e) 18 m

Area between $t = 0$ s and $t = 9$ s : 19 m.

Area between $t = 9$ s and $t = 10$ s : 1 m.

Total area : $19 + 1 = 20$ m.



(c) (ii) Identical forces act for the same length of time on two different masses. The change in momentum of the smaller mass is

(a) smaller than the change in momentum of the larger mass, but not zero
(b) larger than the change in momentum of the larger mass
(c) equal to the change in momentum of the larger mass
(d) zero
(e) equal to the change in its kinetic energy

$\vec{F} \cdot \Delta t = \Delta \vec{p}$

regardless mass.

(e) (iii) A tennis ball accidentally dropped from a helicopter is falling in the air. Taking into account the air resistance, which statement is NOT true?

(a) The drag force due to air resistance is upward.
(b) The faster the ball falls, the stronger the air resistance.
(c) The acceleration will eventually reach zero.
(d) The speed of the ball will reach a maximum value and then unchanged.
(e) The falling speed will decrease.

The falling speed will not decrease.

(C) (iv) A baseball of mass 0.190 kg moving at 30.0 m/s strikes the glove of a catcher. The glove recoils a distance of 8.00 cm. The magnitude of the average force applied by the ball on the glove is

(a) 71.3 N
(b) 0.731 N
(c) 1070 N
(d) 10.7 N
(e) 2140 N

$W = \Delta K$.

$F_{ave} \cdot \Delta x = \frac{1}{2} m v^2$.

$F_{ave} = \frac{m v^2}{2(\Delta x)} = \frac{(0.19\,kg)(30\,m/s)^2}{2(0.08\,m)} = 1070\,N$

(b) (v) Two points, A and B, are on a disk that rotates about an axis. Point A is twice as far from the axis as point B. If the centripetal acceleration of point B is a_c, then what is the centripetal acceleration of point A?

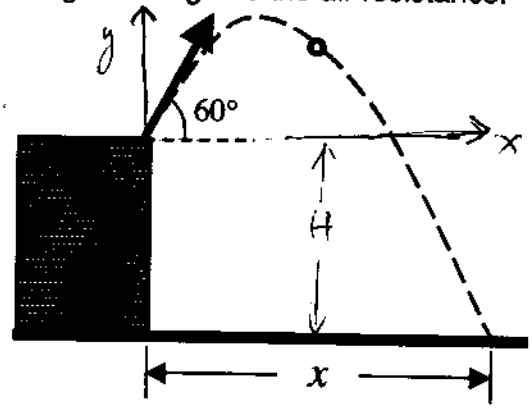
(a) a_c
(b) $2a_c$
(c) $a_c/2$
(d) $4a_c$
(e) $\sqrt{2}\,a_c$

$a_c = r_B \cdot \omega^2$

$a_{cA} = r_A \cdot \omega^2 = 2 r_B \cdot \omega^2 = 2 a_c$.

2 (4 marks). A ball is thrown from the roof of a building at a 60° angle above the horizontal with a speed of 16 m/s. 5.0 seconds later, the ball hits the ground. Ignore the air resistance.

A) Determine height of the building.
B) Find the horizontal distance *x*.



[Solution]. set up coordinate system.

$x_0 = 0$. $y_0 = 0$.

$v_{0x} = v_0 \cos 60°$, $v_{0y} = v_0 \sin 60°$

$a_x = 0$, $a_y = -g$.

$\therefore \begin{cases} x = v_{0x} t \\ y = v_{0y} t - \frac{1}{2} g t^2 \end{cases}$.

at $t = 5$ sec, $y = -H$.

$-H = v_{0y} t - \frac{1}{2} g t^2$

$x = v_{0x} t$.

A): $H = \frac{1}{2} g t^2 - v_{0x} t = \frac{1}{2}(9.81)(5)^2 - (16)\sin 60° (5) = 53.3\,m$.

B): $x = (16)\cos 60° (5) = 40\,m$.

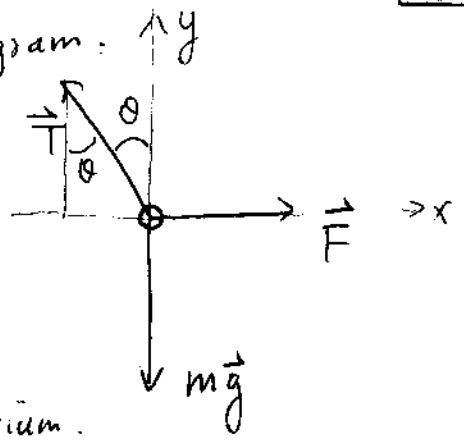
3 (8 marks). In the diagram below, a ball hangs from the ceiling. The length of the string is 1.2m. A horizontal force, F, holds the ball steady. Given F = 10 N and $\theta = 30^\circ$.

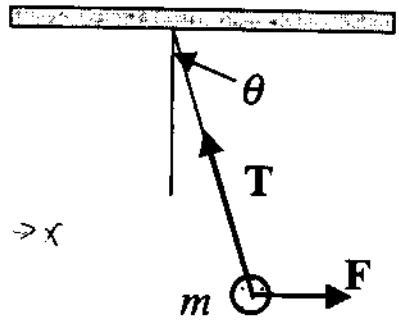
A) Find the magnitude of the tension in the string.

B) If the ball is released (F=0), what will be the speed of the ball when it reaches the bottom?

[Solution]

A) Free-Body Diagram:





static equilibrium.

$\vec{a} = 0$. $\vec{F}_{net} = 0$:

$$\begin{cases} F - T\sin\theta = 0 & (1) \\ T\cos\theta - mg = 0 & (2) \end{cases}$$

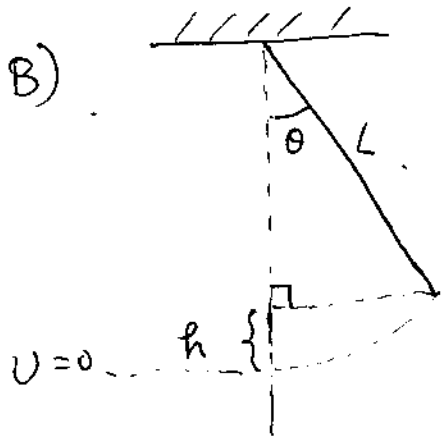
from (1): $T = \dfrac{F}{\sin\theta}$.

(2) becomes: $mg = \dfrac{F\cdot\cos\theta}{\sin\theta}$.

$$m = \frac{F\cdot\cos\theta}{g\sin\theta} = \frac{(10N)(\cos 30^\circ)}{(9.81\ m/s^2)\cdot\sin 30^\circ}$$ ~~1.77 kg~~.

$m = 3.53$ Kg.

B)



$h = L - L\cos\theta$

Conservation of Mechanical Energy

$\Delta E = 0$. or $E_i = E_f$.

$mgh = \frac{1}{2}mv^2$.

$$v = \sqrt{2gh} = \sqrt{2gL(1-\cos\theta)}$$

$$= \sqrt{2(9.81)(1.2)(1-\cos 30^\circ)}$$

= ~~3.43 m/s~~ 1.78 m/s.