Kuwait University **Physics Department**

Physics 101
First Midterm Examination
Summer Semester
Thursday, July 04, 2002
8 AM –9:30 AM

Student's Name: ....الحل النموذجي........ Student's Number: ....

Instructor's Name: ....

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For use by instructors only

Problem	1	2	3	4	5	6	7	8	9	10	Total
Points											

Notes

1. **Answer all questions**
2. **Each question will be assigned 2 points**
3. **The solution should be given explicitly for each problem**
4. **No solution = no points**
5. **Check the correct answer for each question**
6. **Take** $g = 10\ m/s^2$, $\sin 37 = 0.6, \cos 37 = 0.8$
7. **Mobiles and Pagers are not allowed during the exam**

(P1) The position of a body on the x axis varies as a function of time according to the following equation $x = (3t + 2t^2)$ meters, the velocity of the body when t = 3 second is

(a) 12 m/s (b) 15 m/s (c) 4 m/s (d) 0 m/s

$x = 3t + 2t^2$

$\frac{dv}{dt} = 3 + 4t$

$v(3) = 3 + 4(3) = \boxed{15\ m/s}$

(P2) Starting from rest, an object moving with constant acceleration covers a distance of 100 m in 5 seconds. The time required to cover the next 100 meters is

(a) 2 s (b) 3 s (c) 5 s (d) 7 s

$\because \Delta x = v_0 t_1 + \frac{1}{2} a t_1^2 \Rightarrow 100 = 0 + \frac{1}{2} a (5)^2$

$\therefore a = \frac{100}{12.5} = 8\ m/s^2$

for the total interval $\Delta x = v_0 t + \frac{1}{2} a t^2 \Rightarrow 200 = 0 + \frac{1}{2}(8) t^2$

$t^2 = 50 \Longrightarrow t = 7.07$ $\therefore t_t = t_2 + t_1$ $\therefore t_2 = 7 - 5 = \boxed{2\ sec}$

(P3) A stone is thrown vertically downward with a speed of 10 m/s from the top of a building. If it takes 1 second to reach the surface of water, then the time to sink to the bottom of a 5m deep pool with constant velocity is

(a) 1.25 s (b) 1 s (c) 0.25 s (c) 2 s (d) 1.5 s

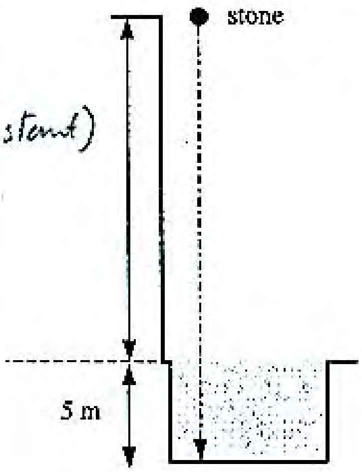
$\because v = v_0 - gt$

$\therefore v = -10 - (10)(1) = -20\ m/s$

for the pool. $\Delta y = -5\ m$, $v = -20\ m/s$ (constant)

$\therefore \Delta y = vt$

$\Rightarrow t = \frac{\Delta y}{v} = \frac{-5}{-20} = \boxed{\frac{1}{4}\ sec}$ #



(P4) If the magnitude of $\vec{A} \times \vec{B} = 4$ and $\vec{A} . \vec{B} = 2$, the angle between the vectors $\vec{A}$ and $\vec{B}$ is

(a) 27° (b) 0 (c) 90 (d) 63°

$|\vec{A} \times \vec{B}| = AB \sin\phi = 4$

$\vec{A} \cdot \vec{B} = AB \cos\phi = 2$

divide both equations

$\frac{AB \sin\phi}{AB \cos\phi} = \frac{4}{2}$

$\tan\phi = 2$

$\boxed{\phi = 63.44^\circ}$ #

(P5) A 1.5 kg object has a velocity of $5\hat{j}$ m/s at t = 0. It is accelerated at a constant rate for 5 seconds after which it has a velocity of $(6\hat{i}+12\hat{j})$ m/s. What is the acceleration during this time interval?

(a) $(6\hat{i}+7\hat{j})m/s^2$ (b) $(1.4\hat{i}+1.2\hat{j})m/s^2$ (c) $(1.2\hat{i}+1.4\hat{j})m/s^2$ (d) $(12\hat{i}+\hat{j})m/s^2$

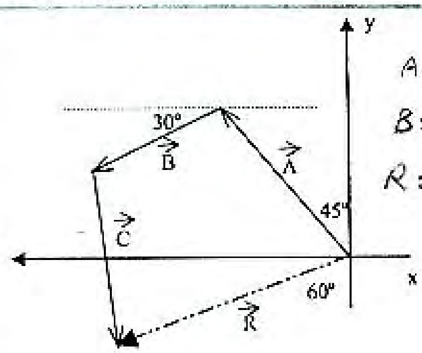
$\because \vec{v} = \vec{v}_0 + \vec{a}t$

$\therefore \vec{a} = \frac{\vec{v}-\vec{v}_0}{t}$

$= \frac{6\hat{i}+12\hat{j}-5\hat{j}}{5} = \boxed{1.2\hat{i}+1.4\hat{j}}$ #

(P6) If A=15, B=10 and R=20, then the vector $\vec{C}$ in unit vector notation is

(a) $1.94\hat{i}-15.60\hat{j}$ (b) $-10.6\hat{i}+10.6\hat{j}$ (c) $1.94\hat{i}+5.6\hat{j}$ (d) $27.32\hat{i}+24.66\hat{j}$



$\vec{A} = -(15\sin 45)\hat{i} + (15\cos 45)\hat{j}$

$\vec{B} = -(10\cos 30)\hat{i} - (10\sin 45)\hat{j}$

$\vec{R} = -(20\sin 60)\hat{i} - (20\cos 60)\hat{j}$

$A = -10.6\hat{i} + 10.6\hat{j}$

$B = -8.66\hat{i} - 5\hat{j}$

$R = -17.32\hat{i} - 10\hat{j}$

$\therefore \vec{A} + \vec{B} + \vec{C} = \vec{R}$

also $A_x + B_x + C_x = R_x$ & $A_y + B_y + C_y = R_y$

$\therefore C_x = R_x - A_x - B_x \Rightarrow C_x = -17.32 - (-10.6) - (-8.66) = 1.94\hat{i}$

also $C_y = R_y - A_y - B_y \Rightarrow C_y = -10 - (10.6) - (-5) = -15.6\hat{j}$

$\therefore C = 1.94\hat{i} - 15.6\hat{j}$

(P7) If the speed of a projectile at the maximum height is 20 m/s and the angle of projection is 60 degrees with horizontal, the range of the projectile is

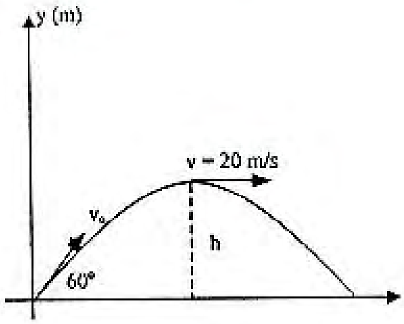
(a) 160 m (b) 80 m (c) 120 m (d) 138.6 m

velocity at the maximum height $= v_{0x}$

$\because v_{0x} = v_0 \cos\theta_0$

$\therefore 20 = v_0 \cos 60°$

$\therefore v_0 = 40\ m/s$



$R = \frac{v_0^2 \sin 2\theta_0}{g}$

$= \frac{(40)^2 \sin 120°}{10} = \boxed{138.6\ m}$ #

(P8) A boat is to cross a 100 m wide river such that it gets to a point due East of where it starts. The boat goes 5 m/s with respect to water and the river flows South at 2 m/s at a uniform speed. How long will it take to cross the river.

(a) 20.00 s (b) 18.58 s (c) 21.83 s (d) 0.07 s

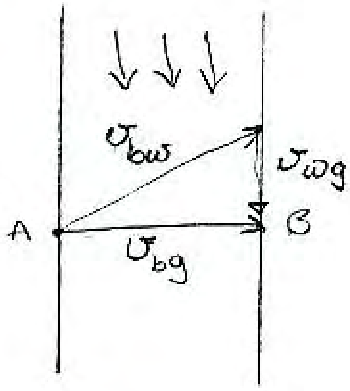
$\vec{v}_{bg} = \vec{v}_{bw} + \vec{v}_{wg} =$

from the triangle $v_{bw}^2 = (v_{bg})^2 + (v_{wg})^2$

$\therefore v_{bw} = \sqrt{(5)^2 - (2)^2} = \sqrt{21} = 4.58$ m/s

$\therefore x = vt \Rightarrow t = \frac{x}{v}$

$\therefore t = \frac{100}{4.58} = \boxed{21.82 \text{ sec}}$ #



(P9) Two blocks of masses m1=10 kg and m2=6 kg are pushed to the right on a frictionless surface by a force F = 100 N which makes an angle of 37 degrees with the horizontal. Find the force exerted by the smaller block on the larger one.

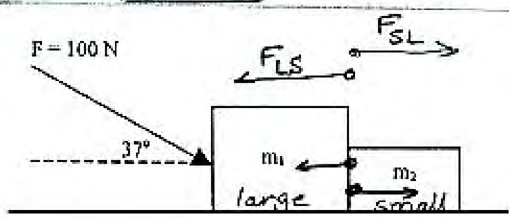
(a) 10 N (b) 20 N (c) 80 N (d) 30 N

Both blocks will accelerate as:

$F_{net} = ma$

$100 \cos 37° = (10 + 6)\, a$

$a = \frac{80}{16} = 5$ m/s



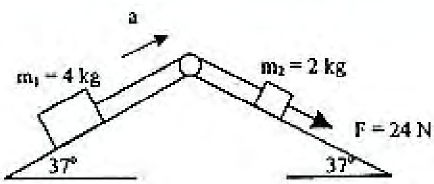
Large block exerts force F_{LS} on the smaller block and the small block exerts force F_{SL} on the larger block. $F_{LS} = -F_{SL}$

$F_{SL} = (6)(5) = 30$ N

$\therefore F_{LS} = -30$ N #

(P10) Find the acceleration of the blocks shown in the figure if the inclined surfaces are smooth.

(a) 1 m/s^2 (2) 2 m/s^2 (3) 4 m/s^2 (4) 6 m/s^2

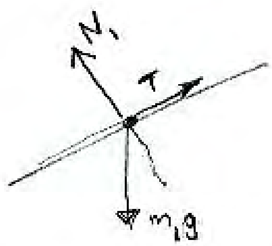


for m_1 (x) $T - m_1 g \sin 37° = m_1 a$ ---- ①

(y) $N_1 - m_1 g \cos 37° = 0$

for m_2 (x) $F + m_2 g \sin 37° - T = m_2 a$ --- ②

(y) $N_2 - m_2 g \cos 37° = 0$



from ① $T - 24 = 4a$ --- ③

from ② $24 + 12 - T = 2a$ --- ④

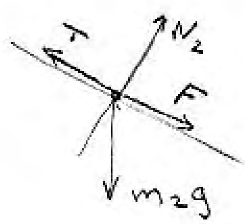
from ③ and ④

$24 + 12 - (4a + 24) = 2a$

$24 + 12 - 4a - 24 = 2a$

$12 = 6a$

$a = \frac{12}{6} = 2$ m/s² #



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[P1]

$$v = \frac{dx}{dt} = 3 + 4t$$

$$v = 3 + 4(3) = 15 m/s$$

[P2]

$$x_1 = v_o t_1 + \frac{1}{2} a t_1^2$$

$$100 = 0 + \frac{1}{2} a (5)^2$$

$$a = \frac{200}{25} = 8 m/s^2$$

$$x_2 = v_o t_2 + \frac{1}{2} a t_2^2 = 200$$

$$t_2 = \sqrt{50} = 7$$

$$t = t_2 - t_1 = 7 - 5 = 2s$$

[P3]

$$v = v_o - gt = -10 - 10(1) = -20 m/s$$

$$t = d/v = 5/20 = 0.25s$$

[P4]

$$AB \sin\theta = 4$$

$$AB \cos\theta = 2$$

$$\tan\theta = 4/2 = 2$$

$$\theta = 63^\circ$$

[P5]

$$v = v_o + at$$

$$a = \frac{v - v_o}{t} = \frac{6\hat{i} + 12\hat{j} - 5\hat{j}}{5} = 1.2\hat{j} + 1.4\hat{j}$$

[P6]

$$\vec{A} = -(15 \sin 45)\hat{i} + (15 \cos 45)\hat{j}$$

$$\vec{B} = -(10 \cos 30)\hat{i} - (10 \sin 30)\hat{j}$$

$$\vec{R} = -(20 \sin 60)\hat{i} - (20 \cos 60)\hat{j}$$

$$\vec{C} = \vec{R} - (\vec{A} + \vec{B}) = 1.94\hat{i} - 15.6\hat{j}$$

[P7]

$$v_{ox} = v_o \cos\theta = 20$$

$$v_o = \frac{20}{\cos 60} = 40 m/s$$

$$R = \frac{v_o^2 \sin 2\theta}{g} = \frac{(40)^2 \sin 120}{10} = 138.6 m$$

[P8]

$$\vec{v}_{bg} = \vec{v}_{br} + \vec{v}_{rg}$$

$$v_{bg} = \sqrt{5^2 - 2^2} = \sqrt{21} = 4.58 m/s$$

$$t = \frac{d}{v_{bg}} = \frac{100}{4.58} = 21.83s$$

[P9]

$$a = \frac{F \cos\theta}{m_1 + m_2} = \frac{100(0.8)}{16} = 5 m/s^2$$

$$F_{12} = P = -m_2 a = -6(5) = -30N$$

[P10]

$$a = \frac{F + m_2 g \sin 337 - m_1 g \sin 37}{m_1 + m_2} = \frac{24 + 20(0.6) - 40(0.6)}{4 + 2} = 2 m/s^2$$