Kuwait University Physics Department

Physics 101

Fall Semester
Second Midterm Exam
Saturday, November 10, 2018
9:00 – 10:30 a.m.

Student's Name: ……..……..…….. Serial #: ……

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

Prof. Yacoub Makdisi	Dr. Tareq Al Refai
Dr. Hala Al-Jassar	Dr. Abdulmohsen
Dr. Ahmed Al-Jassar	Dr. Belal Salameh
Dr. Abdul Khaleq	Dr. Nasser Demir

For Instructors use only

Grades:

#	Q1	Q2	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
Pts	1	1	1	1	2	2	2	2	2	3	3	20

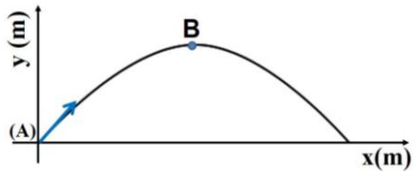
Important:

1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
   i. 4 **Q**uestions
   ii. 5 **S**hort **P**roblems
   iii. 2 **L**ong **P**roblems.
3. No solution = no points.
4. **Use SI units.**
5. Check the correct answer for each question.
6. Assume g = 10 m/s^2.
7. Mobiles are **strictly prohibited** during the exam.
8. Programmable calculators, which can store equations, are not allowed.
9. **Please write down your final answer in the box shown in each problem**.
10. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

Part I: Questions (Choose the correct answer, one mark each)

Q1. A stone is thrown from point A at an angle θ above the horizontal as shown. Neglecting air resistance, **the relation between the velocity and acceleration of the stone when it reaches its maximum height at point B is:**



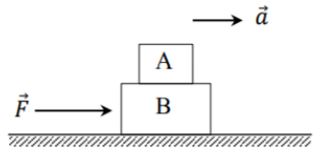
- (*) $\vec{V}_B$ is perpendicular to $\vec{a}_B$
- * $\vec{V}_B$ and $\vec{a}_B$ are in opposite directions.
- * $\vec{V}_B$ and $\vec{a}_B$ are in the same direction.
- * $\vec{V}_B = \vec{a}_B = 0$

Q2. A man stands on a scale in an elevator. If the **man's apparent weight is greater than his real weight** then the elevator moves

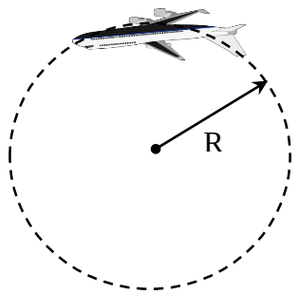
- * upward with decreasing speed.
- (*) downward with decreasing speed.
- * downward with increasing speed.
- * upward with constant speed.

Q3. An applied force $\vec{\mathbf{F}}$ accelerates block B towards the right as shown in the figure. **Block A does not slip with respect to block B**. The **static friction force between the two blocks**

- * acts to the right on both blocks A and B.
- * acts to the left on both blocks A and B.
- (*) acts to the right on block A, but to the left on block B.
- * acts to the left on block A, but to the right on block B.



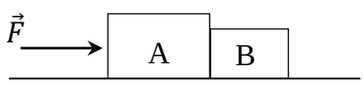
Q4. A pilot is performing a vertical loop of radius R with a plane. **If the pilot feels weightless (n=0) at the top position,** then the speed of the plane at the top position is



- * $v = \sqrt{mgR}$
- * $v = \sqrt{2gR}$
- * $v = \sqrt{\frac{gR}{2}}$
- (*) $v = \sqrt{gR}$

Part II: Short Problems (2 marks each)

SP1. Blocks A and B are in contact on a horizontal **frictionless** surface. Block A has mass 20 kg and block B has mass 5 kg. A horizontal force of F = 75 N is exerted on block A. **What is the magnitude of the force that block B exerts on block A?**



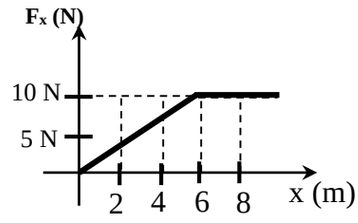
$$F = (m_A + m_B)a$$

$$a = \frac{F}{(m_A + m_B)} = \frac{75}{25} = 3\ m/s^2$$

$$F_{BA} = F_{AB} = m_B a = 5(3) = 15\ N$$

Answer: $F_{BA} = 15$ N

SP2. A 4 kg box moves from the origin along x-axis under the influence of a variable net force whose graph is shown. **<u>If the speed of the box is 12 m/s at x=0 m, find its speed at x=8 m.</u>**



$$\sum W = W_F = \text{Area under the curve} = \Delta K$$

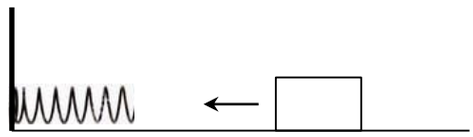
$$\frac{1}{2}(6)(10) + (2)(10) = \frac{1}{2}m(V_f^2 - V_i^2)$$

$$50 = 2(V_f^2 - 12^2)$$

$$V_f = \sqrt{25 + 144} = 13 \text{ m/s}$$

Answer: $V_f = 13$ m/s

SP3. A 6 kg block is moving on **a rough horizontal** surface (μ_k=0.67) toward a relaxed spring with force constant k=200 N/m that is attached to a wall, as shown in the figure. **Find the speed of the block just before it hits the spring if the block compresses the spring <u>a maximum distance</u> of 20 cm.**



$$\sum W = \Delta K$$

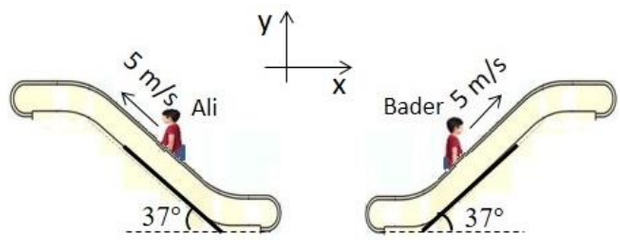
$$W_{F_S} + W_{f_k} = 0 - \frac{1}{2}mV_i^2$$

$$-\frac{1}{2}kd^2 - \mu_k mgd = -\frac{1}{2}mV_i^2$$

$$V_i = \sqrt{\frac{kd^2 + 2\mu_k mgd}{m}} = \sqrt{\frac{(200)(0.2)^2 + (2)(0.67)(6)(10)(0.2)}{6}} = 2 \text{ m/s}$$

Answer: $V_i = 2$ m/s

SP4. Bader and Ali ride two escalators and move as shown in the figure. **<u>Find the velocity of Bader with respect to Ali.</u>**



$$\vec{V}_{B/G} = 5\cos(37^o)\,\hat{\imath} + 5\sin(37^o)\,\hat{\jmath}$$

$$= (4\hat{\imath} + 3\hat{\jmath}) m/s$$

$$\vec{V}_{A/G} = -5\cos(37^o)\,\hat{\imath} + 5\sin(37^o)\,\hat{\jmath}$$

$$= (-4\hat{\imath} + 3\hat{\jmath}) m/s$$

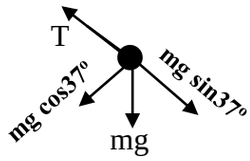
$$\vec{V}_{B/A} = \vec{V}_{B/G} - \vec{V}_{A/G} = 8\,\hat{\imath}\text{ m/s}$$

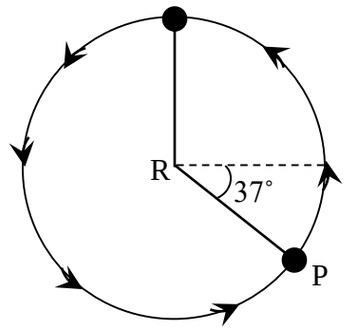
Answer: $\vec{V}_{B/A} = 8\,\hat{\imath}$ m/s

SP5. A ball of mass 2 kg connected to a light rope rotates in a vertical circle of radius R= 4 m, as shown in the figure. If the tension in the rope at point **P** is T=30 N, **find the speed of the ball at point P.**

$$T - mg\sin(37^o) = m\frac{V^2}{R}$$

$$V = \sqrt{\frac{R}{m}(T - mg\sin(37^o))} = 6\ m/s$$



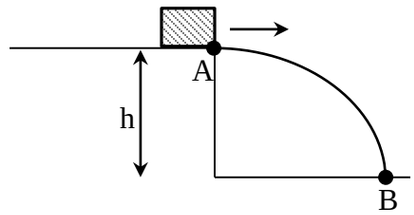


Answer: $V = 6\ m/s$

Part III: Long Problems (3 marks each)

LP1. A block of mass 3 kg is moving on **a frictionless horizontal** table of height h= 1.8 m with a speed of 2.5 m/s. The block leaves point A in the **horizontally direction** then lands at point B, as shown in the figure. Air resistance is negligible.

a. Find the work done by gravity between points A and B.



$W_{mg} = mgh = (3)(10)(1.8) = 54\ J$

$W_{mg} = 54\ J$

Answer: $W_{mg} = 54\ J$

b. Find the time it takes for the block to move from point A to point B.

$$\Delta y = V_{yo}t - \frac{1}{2}gt^2$$

$$-1.8 = 0 - 5t^2 \Rightarrow t = 0.6\ s$$

Answer: $t = 0.6\ s$

c. Find the average power delivered by gravity between points A and B.

$$P = \frac{W}{t} = \frac{54}{0.6} = 90\ W$$

Answer: $P = 90\ W$

LP2. Two blocks (m_1 = 20 kg and m_2 = 4 kg) are connected to a light rope passing over a massless, frictionless pulley as shown in the figure. Block m_1 lies **on a rough incline** (μ_k = 0.2). The system of blocks is **released at t=0 s from rest** and moves as shown.

a. <u>Draw a free-body diagram for each of the two blocks.</u>

b. <u>Find the acceleration of the blocks.</u>

$$n = m_1 g\ cos(36.9^o)$$

$$m_1 g\ sin(36.9^o) - f_k - m_2 g = (m_1 + m_2)a$$

$$m_1 g\ sin(36.9^o) - \mu_k m_1 g\ cos(36.9^o) - m_2 g = (m_1 + m_2)a$$

$$a = \left[\frac{m_1\ sin(36.9^o) - \mu_k m_1 cos(36.9^o) - m_2}{m_1 + m_2}\right] g = 2\ m/s^2$$

Answer: $a = 2\ m/s^2$

c. <u>Find the total work done on the system between t=0 s and t=1 s.</u>

$$\mathrm{V_f} = \mathrm{V_i} + \mathrm{at} = 0 + (2)(1) = 2\ \mathrm{m/s}$$

$$\mathrm{W_{total}} = \Delta \mathrm{K} = \frac{1}{2}\mathrm{m_{total}}\mathrm{V_f^2} - \frac{1}{2}\mathrm{m_{total}}\mathrm{V_i^2} = \frac{1}{2}(24)(2)^2 - 0 = 48\ \mathrm{J}$$

Answer: $\mathrm{W_{total}} = 48\ \mathrm{J}$