Kuwait University — Physics Department

Physics 101

Spring Semester
Second Midterm Exam
Saturday, April 07, 2018
9:00 am – 10:30 pm

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

Student's Number: …..…………………………………… Section: ……………………

Choose your Instructor's Name:

Dr. Ahmed Al-Jassar	Dr. Abdul Mohsen
Dr. Hala Al-Jassar	Dr. Tareq Al Refai
Dr. Fatema Al Dosari	Dr. Abdul Khaleq
Dr. Nasser Demir	Dr. Belal Salameh

For Instructors use only

Grades:

	Q1	[illegible]	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
	[illegible]	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. **Give your final answer in the correct 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. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

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

Q1. Consider a person standing in an elevator that is **accelerating upward**. **The apparent weight of the person is**

(*) larger than the real weight of the person.

* identical to the real weight of the person.

* less than the real weight of the person.

* larger or less than the real weight of the person dependent on the direction of the velocity.

Q2. Which of the following physical concepts best explains why a passenger in a fast moving car should always fasten his seat belt?

* centripetal force

* gravitational acceleration

* gravitational potential energy

(*) inertia

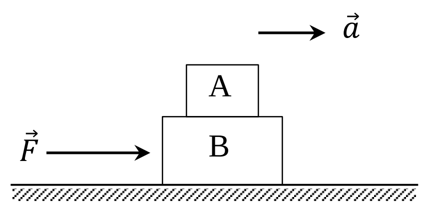
Q3. An applied force accelerates block **B** towards the right as shown in the figure. **Block A, which does not slip with respect to block B,** also accelerates to the right. The **work done by static friction between the two blocks is**

* positive on both A and B.

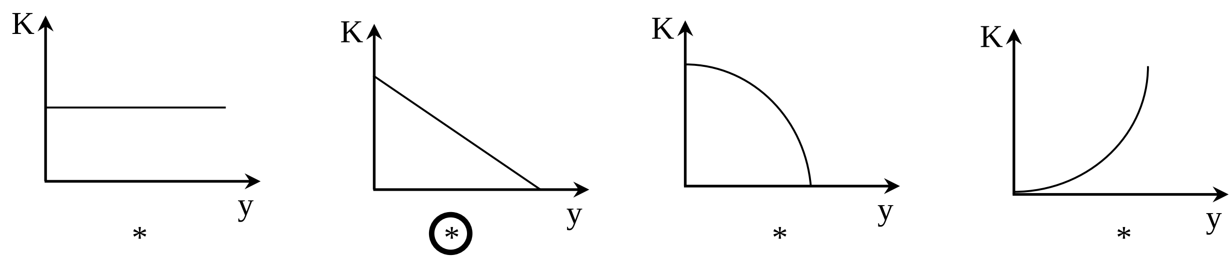
* negative on both A and B.

(*) positive on A, negative on B.

* negative on A, positive on B.



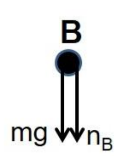
Q4. A ball is thrown straight up into the air from ground level. Neglecting air resistance, which of the following graphs best represents **the kinetic energy K** of the ball **as a function of its position y above ground level**?

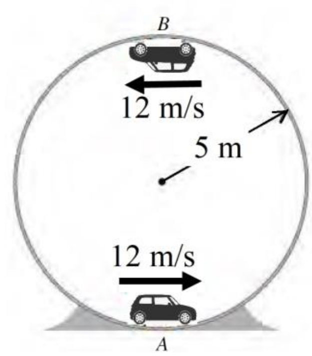


Part II: Short Problems (2 points each)

SP1. A small toy car with m =1.5 kg moves at a constant speed of 12 m/s in a vertical circular track with radius 5 m. What is the **magnitude and direction of the normal force** on the car at the top (point B)?

$$n_B + mg = m\frac{v_B^2}{R}$$





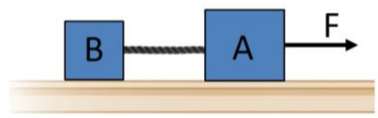
$$n_B = m\left(\frac{v_B^2}{R} - g\right) = 1.5\left(\frac{12^2}{5} - 10\right)$$

$$= 28.2\ N\ \textbf{(Downward)}$$

1/2

Answer: $n_B = 28.2\ N$ **(Downward)**

SP2. Two blocks connected by a massless rope **are initially at rest on a frictionless surface**. Block A of mass 5 kg is **pulled by a constant force of 20 N as shown**. In the first 5 s after the force is applied the system moves 20 m to the right. **Find the tension in the rope between the two blocks.**



$$\Delta x = V_{xi}t + \frac{1}{2}\, a_x t^2$$

$$a = \frac{2\Delta x}{t^2} = \frac{2(20)}{5^2} = 1.6\, m/s^2$$

$$F - T = m_A\, a$$

$$20 - T = 5(1.6) \quad \Longrightarrow T = 12N$$

Answer: $T = 12N$

SP3. A variable net force acts on a 4 kg object moving along the x-axis. The net force is given by $F(x) = 3x^2 + 2x + 1$, where F is measured in N and x is measured in m. If the object starts from rest at the origin, **find the kinetic energy of the object when it reaches the position x=5 m**.

$$W = \Delta K$$

$$W = \int_0^5 F(x)dx = \int_0^5 (3x^2 + 2x + 1)dx = [x^3 + x^2 + x]_0^5 = 155\, J$$

$$155 = K_f - K_i = K_f - 0 \qquad \Longrightarrow \quad K_f = 155\, J$$

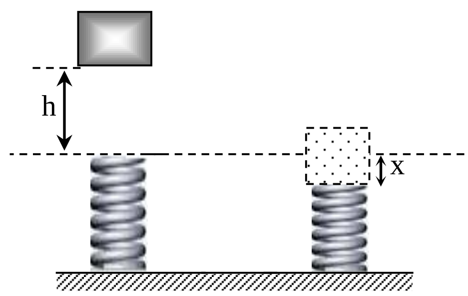
Answer: $K_f = 155\, J$

SP4. A block of mass 2 kg is released from rest a distance h=1.8 m above the top of **an uncompressed** spring of force constant k, as shown in the figure. The spring reaches a maximum compression of x=0.2 m. **Find the force constant k of the spring**. Neglect air resistance.

$$E_1 = E_2$$

$$mg(h + x) = \frac{1}{2}\, kx^2$$

$$2(10)(2) = \frac{1}{2}k(0.2)^2 \quad \Longrightarrow \quad k = 2000\, N/m$$



Answer: $k = 2000\, N/m$

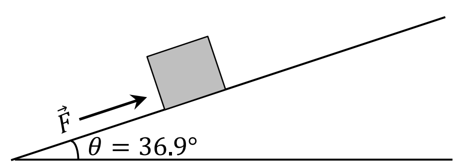
SP5. An applied force F acts on a block of mass 4 kg which is moving up and parallel to **a rough inclined plane** as shown in the figure. The coefficient of kinetic friction between the block and the incline is μ_k=0.3. If the **block moves at a constant speed of 5 m/s, find the power supplied by F** to the block.

$$F = mg \sin\theta + \mu_k\, mg \cos\theta$$

$$= 4(10)\, sin\, 36.9° + 0.3\,(4)(10)\, cos\, 36.9°$$

$$F = 33.6\, N$$

$$\Longrightarrow P_F = \vec{F}\cdot\vec{V} = F\,V = 33.6(5) = 168.1\, W$$

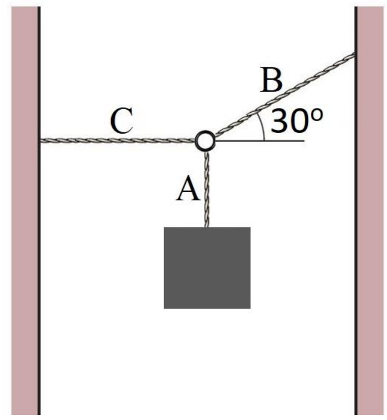


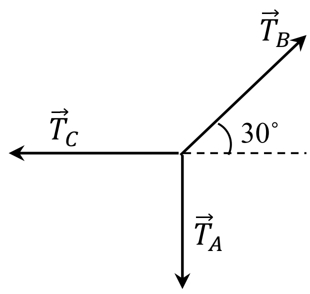
Answer: $P_F = 168.1\, W$

Part III: Long Problems (3 points each)

LP1. A block of mass 20 kg hangs from a light cord (A) that is linked at a very light O ring to two other light cords (B and C), the two cords are fastened to two vertical walls as shown in the figure.

a. Draw a free body diagram of the O ring.





b. Find the tension in the cords A, B, and C.

$$T_A = mg = 20(10) = 200\ N$$

$$T_B \sin 30^o = T_A \qquad \Longrightarrow \qquad T_B = \frac{T_A}{\sin 30^o} = 400\ N$$

$$T_C = T_B \cos 30^o = 346.4\ N$$

Answer: $T_A = 200N$

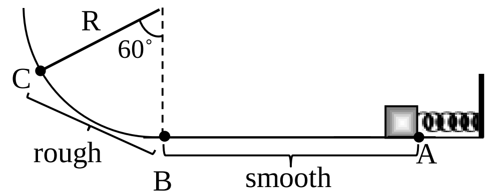
Answer: $T_B = 400\ N$

Answer: $T_C = 346.4\ N$

LP2. A block of mass 2 kg is pushed against a spring of force constant k = 4000 N/m. The block is released from rest at point A when the spring is compressed a distance of x = 0.2 m. The block slides on **a horizontal frictionless** surface before entering a **rough** curved surface as shown in the figure. The radius of the curved portion is R=3 m, and the **block's speed is 6 m/s when it reaches point C**.

a. Find the work done by the normal force on the block between points A and C.

$$W_n(A \to C) = 0 \qquad (\vec{n} \perp d\vec{r})$$



Answer: $W_n = 0$

b. Find the work done by friction on the block between points B and C.
(Hint: use the conservation of energy or work energy theorem)

$$\Delta y = R(1 - \cos\theta)$$

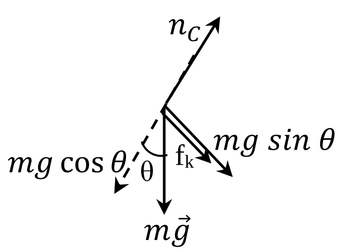
$$E_C - E_A = W_f$$

$$\left[\frac{1}{2}mV_C^2 + mg\,R(1-\cos\theta)\right] - \frac{1}{2}\,kx^2 = W_f$$

$$W_f = \left[\frac{1}{2}\,(2)(6)^2 + 2(10)(3)(1-\cos 60°)\right] - \frac{1}{2}(4000)(0.2)^2 = -14\,J$$

Answer: $W_f = -14\,J$

c. Find the magnitude of the normal force on the block when it reaches point C.



$$n_C - mg\ cos\ \theta = \frac{mV_C^2}{R}$$

$$n_C = 2\left(\frac{v_C^2}{R} + g\ cos\ \theta\right)$$

$$= 2\left(\frac{6^2}{3} + 10\ cos\ 60°\right)$$

$$n_C = 34\ N$$

Answer: $n_C = 34\ N$