Kuwait University — Physics Department

Physics 101

Fall Semester
Second Midterm Exam
Saturday, December 9, 2023
8:00 AM – 9:30 AM

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

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

Choose your Instructor's Name:

Instructors: Drs. Al Dosari, Al Jassar, Al Kurtas, Al Qattan, Al Refai, Al Smadi, Askar, Demir, Salameh

For Instructors use only

Grades:

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

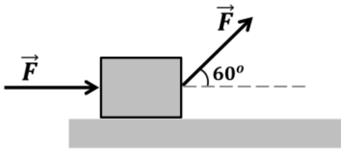
Important:

1. Answer all questions and problems (no solution = no points).
2. Full mark = 20 points as arranged in the above table.
3. **Give your final answer in the correct units.**
4. Assume g = 10 m/s^2.
5. Mobiles are **<u>strictly prohibited</u>** during the exam.
6. Programmable calculators, which can store equations, are not allowed.
7. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

Part I: Short Problems (2 points each)

SP1. A block ($m = 6\ kg$) slides on a **frictionless** surface under the action of two forces, with the same magnitude $|\vec{F}| = 20\ N$, as shown. **Find the magnitude of the block's acceleration.**

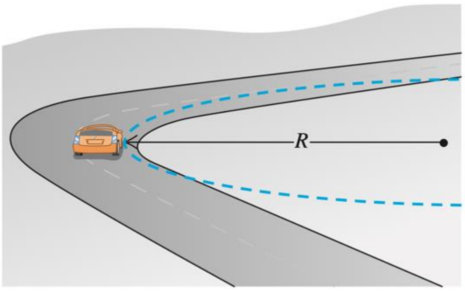


$$F + F\ cos\theta = ma$$

$$20 + 20\ cos\ 60^o = 6a$$

$$a = 5\ m/s^2$$

SP2. A car is rounding **a flat unbanked curve** at a speed of 120 km/h. If the coefficient of static friction of the tire on the road is $\mu_s = 0.6$, **what is the minimum radius of the curve such that the car does not slip?**

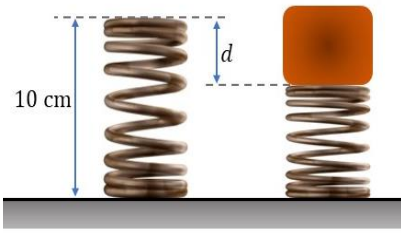


$$F_r = \frac{mv^2}{R}$$

$$F_r = f_{s_{max}} = \mu_s mg = \frac{mv^2}{R}$$

$$R = \frac{v^2}{\mu_s g} = \frac{(120/3.6)^2}{0.6\times10} = 185.2\ m$$

SP3. A spring of force constant $k = 140\ N/m$ and a relaxed length of $10\ cm$ is mounted vertically on the ground, as shown. You compress a 150 g block on the spring a distance d and release it from rest**. Find the value of *d* so that the block reaches a maximum height of <u>15 cm above the ground</u>?**



$$E_i = E_f$$

$$\frac{1}{2}kd^2 = mg(d + 0.05)$$

$$d = 0.045\ m = 4.5\ cm$$

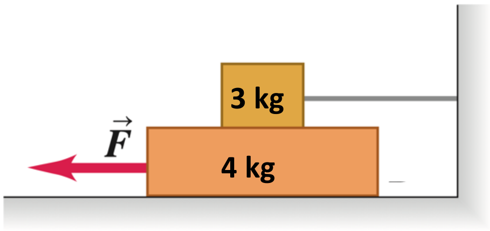
SP4. A 10 kg object starts from **the origin** with an initial speed of 3 m/s and undergoes a displacement of $\vec{S} = (5\hat{\imath} + 3\hat{\jmath} + 3\hat{k})\ m$, while a net **constant** force $\vec{F} = (-3\hat{\imath} + \hat{\jmath} + 4\hat{k})\ N$ acts on it. **Use the work-energy theorem and calculate its final speed.**

$$w = \vec{F}.\vec{S} = -3(5) + 1(3) + 4(3) = 0\ J$$

$$w = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = 0$$

So, $v_f = v_i = 3\ m/s$

SP5. Consider the following system shown in the figure. The coefficient of static friction between all surfaces is $\mu_s = 0.8$. **Find the magnitude of the horizontal force $\vec{F}$ that must be applied to the 4 kg block to just make it move.**



For the 4 kg block: $\sum F_x = 0$

$$F - (f_{s1})_{max} - (f_{s2})_{max} = 0$$

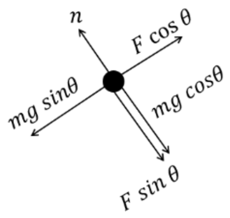
$$F - \mu_s(m_{tot}g) - \mu_s(m_1 g) = 0$$

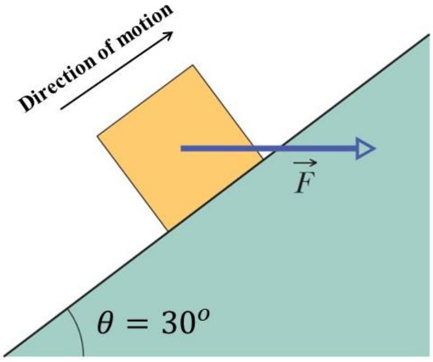
$$F = 0.8(70) + 0.8(30) = 80\ N$$

Part II: Long Problems (3 points each)

LP1. A crate of mass $m = 100$ kg is pushed at **constant speed** up **a frictionless** ramp by a horizontal force $\vec{F}$, as shown.

a) Draw the free body diagram of the crate.





b) What is the magnitude of the force $\vec{F}$?

For m: $\sum F_x = ma = 0$

$$F cos\theta - mg sin\theta = 0$$

$$F cos\theta = mg sin\theta$$

$$F = \frac{mg\ sin\theta}{cos\theta} = 577.4\ N$$

c) What is the magnitude of the normal force exerted on the crate by the ramp?

For m: $\sum F_y = 0$

$$n - F sin\theta - mg\ cos\theta = 0$$

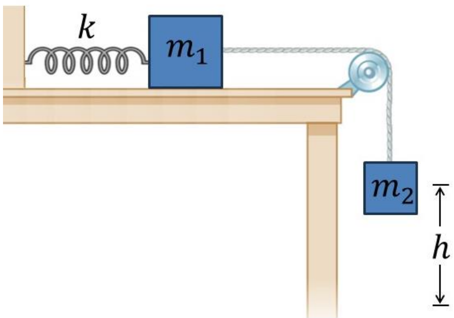
$$n = F\ sin\theta + mg\ cos\theta$$

$$n = 577.4\ sin30^o + 1000\ \cos 30^o = 1154.7\ N$$

LP2. Two blocks ($m_1 = 5\ kg$ and $m_2 = 3\ kg$) are connected by a light string which passes over a massless pulley, as shown. The block m_1 is connected to a spring of force constant $k = 400\ N/m$ on **a rough surface**. Initially the system **is released from rest when the spring is unstretched**. The block m_2 descends a distance $h = 0.1\ m$ **before coming to rest.**

a) Find the change in the elastic potential energy during this motion.

$$\Delta U_{el} = \frac{1}{2}kx_f^2 - \frac{1}{2}kx_i^2 = \frac{1}{2}(400)(0.1)^2 - 0 = +2J$$



b) Find the coefficient of kinetic friction between m_1 and the surface.

$$E_f - E_i = W_{other}$$

$$\frac{1}{2}kx_f^2 - m_2gh = -\mu_k m_1 g d$$

$$\frac{1}{2}(400)(0.1)^2 - 3(10)(0.1) = -\mu_k(5)(10)(0.1)$$

$$\mu_k = 0.2$$

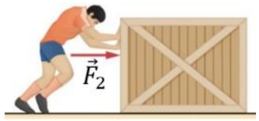
c) During this motion, the work done on m_2 by the tension in the string is

*** positive.** *** negative.** *** zero**

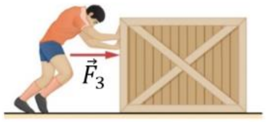
Part III: Questions (Choose the correct answer, one point each)

Q1. A man exerts a horizontal force to push a box, as shown. In **case I**, the box remains **at rest**, while in case **II**, the box is **about to move**, and in case **III**, the box is moving with **constant speed**. **In which of the three cases the man applies the maximum force?**

Case I
The box is at rest.



Case II
The box is about to move.



Case III
The box is moving at constant velocity.

* The man applies the same force in all cases. * Case I. * Case II. * Case III.

Q2. Power has the unit of

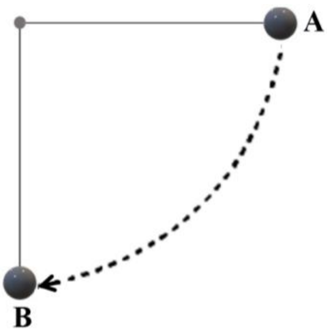
* $kg\ m/s^3$

* $kg\ m^2/s$

* $kg\ m^2/s^3$

* $kg\ m^2/s^2$

Q3. A pendulum's bob **is released from rest at point A,** as shown. The relation between **the magnitudes of the accelerations at point B, $|\vec{a}_B|$, and at point A, $|\vec{a}_A|$, is**:



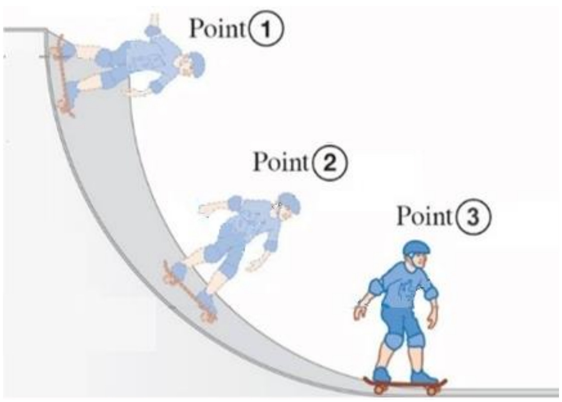
* $|\vec{a}_B| < |\vec{a}_A|$

* $|\vec{a}_B| > |\vec{a}_A|$

* $|\vec{a}_B| = |\vec{a}_A| \neq 0$

* $|\vec{a}_B| = |\vec{a}_A| = 0$

Q4. A boy skateboards **from rest** down a quarter-circle curved **rough** ramp from point 1 to point 3, where **half the way is at point 2**, as shown. If the work done on him by **friction force** from point 1 to point 2 is $W_{f_{1-2}}$ and from point 2 to point 3 is $W_{f_{2-3}}$, then:



* $\left|W_{f_{2-3}}\right| < \left|W_{f_{1-2}}\right|$

* $\left|W_{f_{2-3}}\right| > \left|W_{f_{1-2}}\right|$

* $\left|W_{f_{2-3}}\right| = \left|W_{f_{1-2}}\right| = 0$

* $\left|W_{f_{2-3}}\right| = \left|W_{f_{1-2}}\right| \neq 0$