Kuwait University Physics Department

Model Answer

Physics 101

Fall Semester

Second Midterm Exam

Saturday, November 30, 2024

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, Zaman

Model Answer

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	20

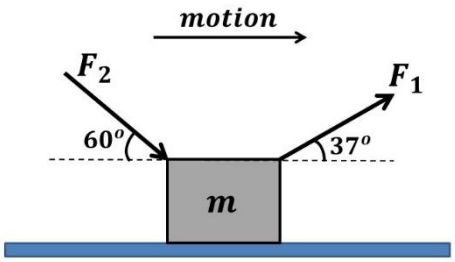
Important:

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 **strictly prohibited** 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. Two forces, $F_1 = 25\ N$ and $F_2 = 40\ N$, act on a $20\ kg$ block that moves on **a frictionless** horizontal surface, as shown. **Find the acceleration (in m/s^2) of the block**.



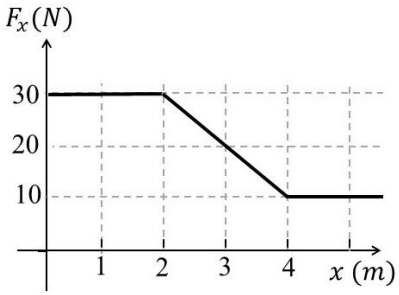
$$\sum F_x = ma_x$$

$$F_1 \cos 37^o + F_2 \cos 60^o = ma_x$$

$$25 \cos 37^o + 40 \cos 60^o = 20a_x$$

$$a_x = 2\ m/s^2$$

SP2. A **single force** F_x acts on a particle, F_x varies with position as shown. **Find the total work (in joules) done on the particle as it moves from $x = 0$ m to $x = 4$ m.**

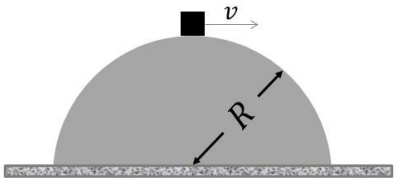


$$W = Area$$

$$= (2)(30) + \frac{1}{2}(2)(20) + (2)(10)$$

$$= 100\ J$$

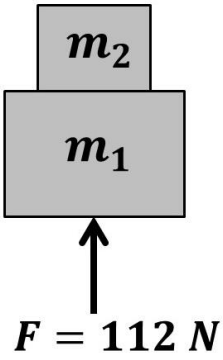
SP3. A 7 kg block slides on a semicircular hump of radius $R = 21\ m$, as shown. If the force exerted on the block by the surface at the top of the hump is 58 N, **find the speed (in m/s) of the block at the top**.



$$mg - n = m\frac{v^2}{R}$$

$$v = \sqrt{\frac{R}{m}(mg - n)} = \sqrt{\frac{21}{7}(7(10) - 58)} = 6\ m/s$$

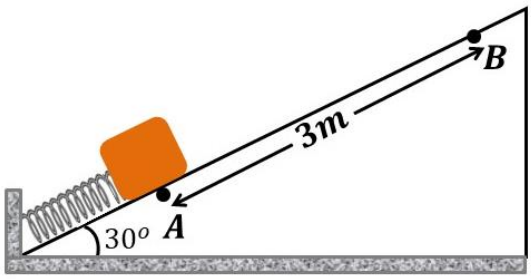
SP4: Two blocks, $m_1 = 5\ kg$, and $m_2 = 3\ kg$, are pushed **vertically up by a force $F = 112\ N$,** as shown. **Find the magnitude of the force (in newtons) exerted on m_2 by m_1.**



$$F - (m_1 + m_2)g = (m_1 + m_2)a \Rightarrow a = \frac{F - (m_1 + m_2)g}{(m_1 + m_2)} = 4\ m/s^2$$

$$F_{12} - m_2 g = m_2 a \Rightarrow F_{12} = m_2(a + g) = 42\ N$$

SP5. A $4\ kg$ block is released **from rest** at point **A** when the spring ($k = 3600\ N/m$) is **<u>compressed</u>** a distance of $x = 0.3\ m$. The block slides up **a rough** incline, **leaves** the spring, and reaches point B with a speed of $5\ m/s$. **Find the coefficient of kinetic friction (μ_k) between the block and the incline**.



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

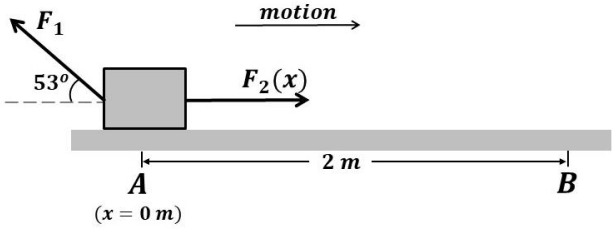
$$\left(mgh_B + \frac{1}{2}mv_B^2\right) - \frac{1}{2}kx^2 = -\mu_k mg\cos(30^o)d$$

$$\left(4(10)(3\ sin(30^o)) + \frac{1}{2}(4)(5)^2\right) - \frac{1}{2}(3600)(0.3)^2 = -\mu_k(4)(10)cos(30^o)(3)$$

$$\mu_k = 0.5$$

Part III: Long Problems (3 points each)

LP1. A 6 kg block **starts from rest at point A** and moves to point **B** on **a frictionless** horizontal surface under the influence of **two forces**. One force, $\boldsymbol{F_1}$**, is constant**, while the other force, $\boldsymbol{F_2(x)}$**, varies** according to the equation $F_2(x) = 400x + 60$, where $F_2(x)$ is in newtons and x is in meters. **The speed of the block at point B is** $\boldsymbol{12\ m/s}$**.**



a) Find the work done on the block by the force $\boldsymbol{F_2(x)}$ during this motion.

$$W_{F_2(x)} = \int_0^2 (400x + 60)dx = (200x^2 + 60x)]_0^2 = 920\ J$$

b) Find the total work done on the block during this motion.

$$W_{total} = \Delta K = \frac{1}{2}m\left(v_f^2 - v_i^2\right) = \frac{1}{2}(6)(12^2 - 0^2) = 432\ J$$

c) Find the magnitude of the force $\boldsymbol{F_1}$.

$$W_{F_1} = W_{total} - W_{F_2(x)} = -488 = (F_1)(s)cos127$$

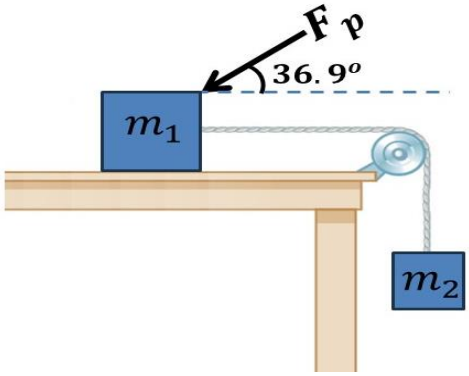
$$F_1 = \frac{W_{F_1}}{s\ cos127^o} = \frac{-488}{2\ cos127^o} = 405.4\ N$$

LP2. Two blocks ($m_1 = 20\ kg$, and $m_2 = 15\ kg$) are connected by a light rope that passes over a massless and frictionless pulley, as shown. Block m_1 rests on **a rough** horizontal surface ($\mu_s = 0.6$). A pushing force ($\boldsymbol{F_p}$) is applied to block m_1, such that **it keeps $\boldsymbol{m_1}$ <u>at rest</u> and about to move <u>to the left.</u>**

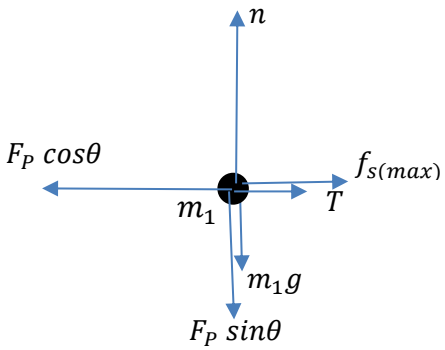
a) Find the tension in the rope.

$m_2 g - T = 0$

$T = m_2 g = 150\ N$



b) Drow the free-body diagram of the block $\boldsymbol{m_1}$.



c) Find the magnitude of the pushing force $\boldsymbol{F_p}$.

$n = F_p \sin(36.9^o) + m_1 g$

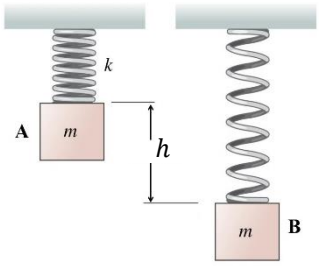
$F_p \cos(36.9^o) - T - f_{s_{max}} = 0$

$F_p \cos(36.9^o) - T - \mu_s(F_p \sin(36.9^o) + m_1 g) = 0$

$$F_p = \frac{T + \mu_s m_1 g}{\cos(36.9^o) - \mu_s \sin(36.9^o)} = 614.4\ N$$

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

Q1. A block of mass (m) is attached to a spring of force constant (k), the spring is connected to the ceiling, as shown. The block is released **from rest at point A** and comes **momentarily to rest at point B**. The **total work** done on the block between points A and B equals



* mgh
* $-\frac{1}{2}kh^2$
* $mgh+\frac{1}{2}kh^2$
* ⊛ $Zero$

Q2. A stone is dropped from the top of a building. As the stone falls, **the instantaneous power delivered by the force of gravity** on the stone

* ⊛ increases.
* decreases.
* stays the same.
* equals zero.

Q3. A single force is applied to a block along the +x direction, causing it to move on a horizontal **frictionless** surface along the +x-axis. **The magnitude of this force decreases over time**. **Which of the following statements is correct?**

* The block's acceleration increases with time.
* The block moves with constant acceleration.
* ⊛ The block's speed increases with time.
* The block's speed decreases with time.

Q4. Two boys of **different masses** pull one another using a horizontal light rope, as shown. Each boy applies a force of 230 N on the rope, **but neither boy moves**. **Which of the following statements is true?**

* The tension in the rope is 460 N.
* ⊛ The tension in the rope is 230 N.
* The force of friction on each boy is 460 N.
* The heavier boy experiences a larger force of friction.