Kuwait University Physics Department

Physics 101

Spring Semester
Second Midterm Exam
Saturday, April 6, 2019
9:00 am – 10:30 am

Model Answer

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

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

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

For Instructors use only

Grades:

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

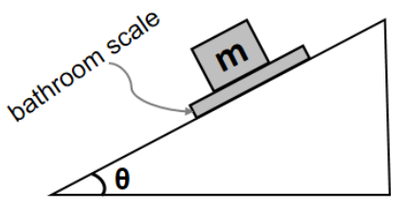
Important:

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

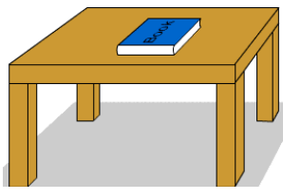
Part I: Questions (Choose the correct answer, one point each)

Q1. A block of mass **(m)** rests on a bathroom scale which is fixed on an incline as shown. **The reading of the scale will be**



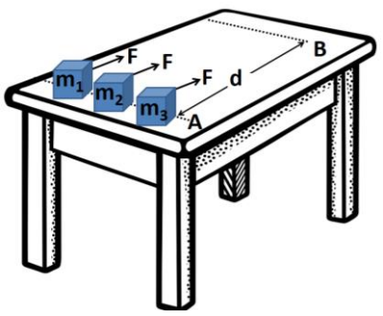
- ⊛ less than mg
- * greater than mg
- * equal to mg
- * less than mg or greater than mg depending on the value of θ.

Q2. A book rests on a table. **The reaction force to the book's weight is the force exerted by:**



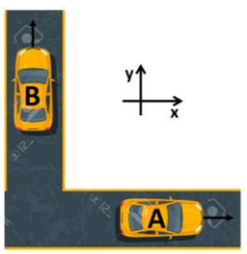
- * earth on the book
- ⊛ book on the earth
- * book on the table
- * table on the book

Q3. Three blocks ($m_1 > m_2 > m_3$) rest on a frictionless table at position **A**. Three forces of equal magnitude **(F)** acted on the blocks and they moved the same distance **(d)** to position **B,** as shown. **Which of the three blocks will have the highest kinetic energy at position B.**



- * m_1
- * m_2
- * m_3
- ⊛ all the same

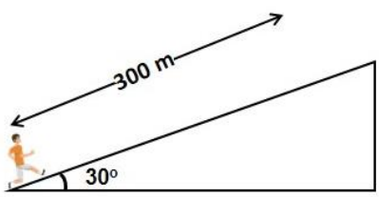
Q4. Car A moves along the positive x-axis and car B moves along the positive y-axis, as shown. **The angle (θ) between the positive x-axis and the velocity of car A relative to car B ($\vec{V}_{A/B}$) is**



- * $\theta = 0^o$
- * $90^o < \theta < 180^o$
- * $180^o < \theta < 270^o$
- ⊛ $270^o < \theta < 360^o$

Part II: Short Problems (2 points each)

SP1. A 60 kg man runs **at a constant speed** a distance d=300 m up a mountain inclined at 30° to the horizontal in 2 minutes. **What is the average power output (in W) of the man during this time period?**



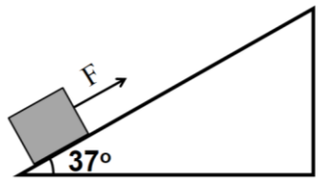
$$P_{av} = \frac{W}{t}$$

$$= \frac{m\,g\,d\sin(\theta)}{t} = \frac{(60)(10)(300)\sin(30^o)}{120}$$

$$= 750\ w$$

Answer: $P_{av} = 750$ w

SP2. A force of magnitude F=300 N pulls a 20 kg block along **a rough incline** (μ_k=0.4) as shown**. Find the acceleration (in m/s^2) of the block.**



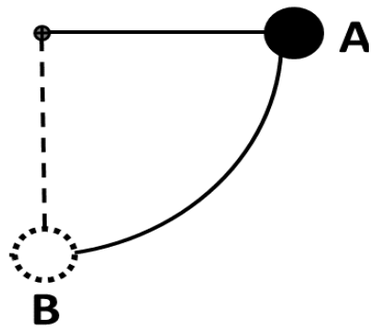
$$F - mg\sin(37^o) - \mu_k mg\cos(37^o) = ma$$

$$a = \frac{F - mg\sin(37^o) - \mu_k mg\cos(37^o)}{m}$$

$$= \frac{300 - 200\sin(37^o) - 0.4(200)\cos(37^o)}{20} = 5.8\ m/s^2$$

Answer: $a = 5.8\ m/s^2$

SP3. A pendulum has a cord of length L = 1.8m. The bob (m=0.4 kg) is released **from rest** at point A, as shown. **Find the tension (in N) in the cord <u>at point B.</u>**



$$mgh_A = \frac{1}{2}mV_B^2 \Rightarrow V_B = \sqrt{2gh_A} = 6\ m/s$$

$$T_B - mg = m\frac{V_B^2}{R} \Rightarrow T_B = m\left(g + \frac{V_B^2}{R}\right) = 0.4\left(10 + \frac{36}{1.8}\right) = 12\ N$$

Answer: $T_B = 12$ N

SP4. A net force $F_x = (4+3x^2)$ N acts on a 4 kg object along the x-axis. If the speed of the object at the origin (x= 0 m) is 4.9 m/s**, find its speed (in m/s) at x =6 m?**

$$W_{F_x} = \int_0^6 F_x dx = \int_0^6 (4 + 3x^2)dx = \frac{1}{2}m(V_f^2 - V_i^2)$$

$$4x + x^3]_0^6 = \frac{1}{2}(4)(V_f^2 - 4.9^2)$$

$$240 = 2(V_f^2 - 24) \Rightarrow V_f = \sqrt{144} = 12\ m/s$$

Answer: $V_f = 12$ m/s

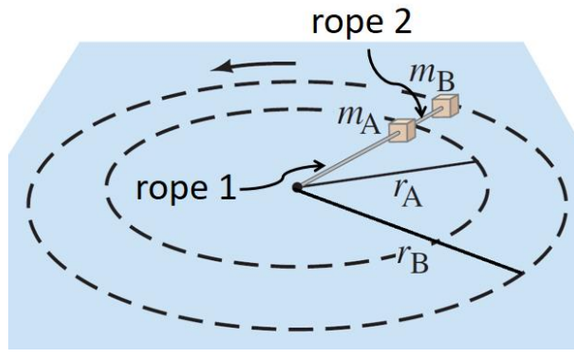
SP5: Two blocks (m_A=4 kg and m_B=5 kg) are connected to each other and to a central post by two thin ropes as shown. The blocks rotate on **a frictionless horizontal surface** in circles of radii (r_A =0.6 m and r_B=0.9 m) at **constant speeds** ($V_A = 2\text{m/s}$ and $V_B = 3\text{m/s}$). **Find the tension (in N) in rope 1.**

$$T_1 - T_2 = m_A \frac{V_A^2}{r_A}$$

$$T_2 = m_B \frac{V_B^2}{r_B}$$

$$\Rightarrow T_1 = m_A \frac{V_A^2}{r_A} + m_B \frac{V_B^2}{r_B}$$

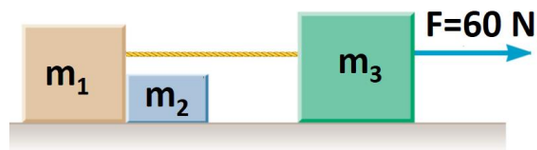
$$= 4\left(\frac{2^2}{0.6}\right) + 5\left(\frac{3^2}{0.9}\right) = 76.7 \text{ N}$$



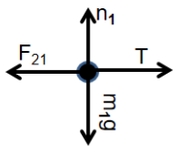
Answer: $T_1 = 76.7$ N

Part III: Long Problems (3 points each)

LP1. Three blocks (m_1=3.4 kg, m_2=2.1 kg, m_3=4.5 kg) move on **a frictionless surface** and a 60 N force acts on m_3 as shown. The cord connecting m_1 and m_3 is massless.



(a) Draw the free body diagram for m_1.



(b) Find the acceleration (in m/s^2) of the system.

$$\sum F = (m_1 + m_2 + m_3)\, a$$

$$a = \frac{\sum F}{(m_1 + m_2 + m_3)} = \frac{60}{1\,0} = 6 \text{ m/s}^2$$

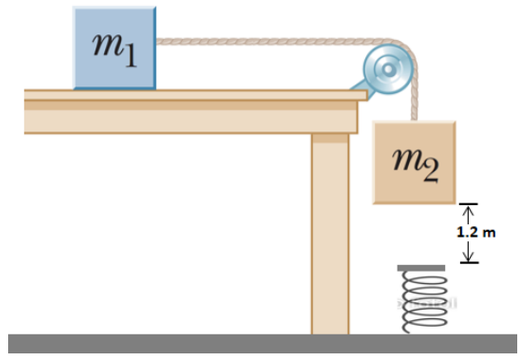
Answer: $a = 6$ m/s^2

(c) Find the force (in N) exerted on m_2 by m_1.

$$F_{12} = m_2 a = 12.6 \text{ N}$$

Answer: $F_{12} = 12.6$ N

LP2. Two blocks (m_1=6 kg and m_2= 2 kg) are connected by a light rope that passes over a massless pulley as shown. The surface of the **table is frictionless** and m_2 is **released** when it is 1.2 m above a relaxed vertical spring.



a) Find the speed (in m/s) of m_2 just before it touches the spring.

$$E_f = E_i$$

$$\frac{1}{2}(m_1 + m_2)V^2 = m_2 g h$$

$$V = \sqrt{\frac{2\, m_2 g h}{(m_1 + m_2)}}$$

$$= \sqrt{\frac{2(2)(10)(1.2)}{8}} = 2.45 \text{ m/s}$$

Answer: $V = 2.45$ m/s

b) If the spring is compressed to <u>a maximum distance</u> of 0.4 m, find the spring constant (k) (in N/m).

$$\frac{1}{2} m_2 V^2 + m_2\, g\, x_{max} = \frac{1}{2} k\, x_{max}^2$$

$$\frac{1}{2}(2)(6) + 2(10)(0.4) = \frac{1}{2} k\, (0.4)^2$$

$$k = 175 \text{ N/m}$$

Answer: $k = 175$ N/m