THE UNIVERSITY OF JORDAN **PHYSICS DEPARTMENT**

PHYSICS 105 (First Exam) **Second Semester (12/3/ 2018)**

Student's Name (Arabic):..... Registration #.....

Lecturer's Name:..... Section # .....

CONSIDER (ACCELERATION DUE TO GRAVITY) g = 9.8 m/s^2

Q1) Two objects with masses $M_A = M$ and $M_B = 2M$ are released from rest at the same height h above the ground. Ignoring air resistance, which of the following statements is correct?

A) M_B reaches the ground before M_A.
B) M_A reaches the ground before M_B.
C) M_A and M_B reach the ground at the same time.
D) M_A and M_B have the same speed just before hitting the ground.
E) Answers C and D are correct.

Q2) A car moves along the x - direction such that its position as a function of time is given by $x = t^2 + t - 2$, where x is in meters and t in seconds. The average velocity (in m/s) of the car during the time interval t = 1 to 3 seconds is:

A) 3 B) 10 C) 0 D) 5 E) 3

Q3) A car is moving at a constant velocity v. Upon applying the brakes the car decelerates uniformly and stops after moving a distance D. If the initial velocity is $2v$ the stopping distance becomes:

A) 2D B) 4D C) D D) 6D E) 0.5D

Q4) A stone is thrown vertically upward with a speed of 18 m/s from the edge of a cliff 60 m high. The time (in s) it takes the stone to reach the bottom of the cliff is:

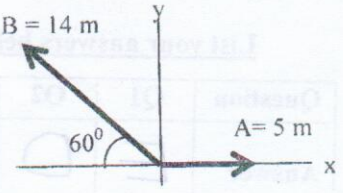
A) 2.1 B) 28.4 C) 18.2 D) 9.6 E) 5.8

Q5) A man starts from the origin and walks 20 m along the positive x – axis. He then turns around and moves 12 m along the negative x –axis. If the time of the whole trip is 6 s, then his average speed (in m/s) is

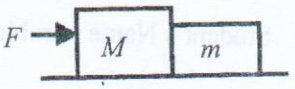
A) 5.3 B) 1.3 C) 3.3 D) 0 E) 2.0

Q6) Vectors A and B are represented as shown in the figure. What is the angle of their resultant $\vec{R} = \vec{A} + \vec{B}$ with respect to the positive x-axis?

A) 44.5° B) 135.5° C) 77°
D) 99.4° E) 112°

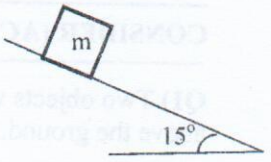


Q7) A block of mass $M = 6.0$ kg is in contact with another block of mass $m = 4.0$ kg on a rough horizontal surface. The coefficient of kinetic friction $\mu_k = 0.2$ and a force $F = 25$ N is applied as shown in the figure. What is the magnitude of the force (in N) of block M on the smaller block m?



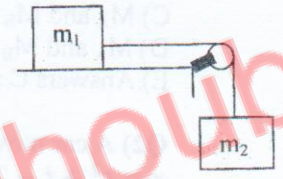
A) 10.0 N B) 16.3 N C) 2.2
D) 25.0 N E) 17.2 N

Q8) In the figure mass m = 2 kg and the coefficients of static and kinetic friction are $\mu_s = 0.4$, $\mu_k = 0.2$ respectively. The acceleration (in m/s^2) of mass m is:



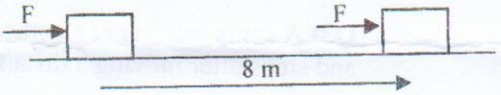
A) 0.64 B) 0 C) 9.8 D) 1.3 E) 2.0

Q9) In the figure the coefficient of kinetic friction between the mass m_1 and the horizontal surface is $\mu_k = 0.10$ and $m_1 = 4.0$ kg, $m_2 = 2.0$ kg. As m_2 moves down, the acceleration of the system (in m/s^2) is:



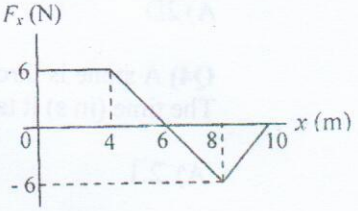
A) 2.6 B) 3.3 C) 9.8 D) 7.8 E) 0

Q10) In the figure, a constant external force $F = 120$ N is applied to a 20-kg box, which is on a rough horizontal surface. The force pushes the box a distance of 8.0 m, in a time interval of 4.0 s, and the speed changes from $v_i = 0$ to $v_f = 3$ m/s. The work done (in J) by the force of friction is



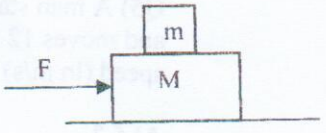
A) +960 B) +870 C) −90
D) −960 E) −870

Q11) The figure shows the force F_x that acts on a 2 kg mass moving along the x-axis. The mass starts from the origin with an initial velocity of 3 m/s. Its final speed (in m/s) at $x = 10$ m is:



A) 7.1 B) 4.2 C) 0
D) 5.2 E) 6.1

Q12) In the figure shown the horizontal surface is frictionless and M = 4 kg, m = 2 kg. If the coefficients of static and kinetic friction between the surfaces of blocks m and M are $\mu_s = 0.4$ $\mu_k = 0.2$, then the maximum allowed value of the force F (in N) such that block m does **not slide** is:



A) 11.8 B) 3.9 C) 7.8 D) 23.5 E) 47.0

List your answers below IN CAPITAL LETTER. ONLY answers in this table will be graded

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Answer	E	D	B	E	A	D	A	B	A	E	D	D

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First Exam Solutions / Physics for Medical Students (105)
Solutions by Prof. Mahmoud Jaghoub / 12/3/2018

Q1] Both masses started from rest at the same height and the have the same gravitational acceleration $\Rightarrow$ the reach the ground at the same time with the same velocity.

Q2] $\bar{v}_{1-3} = \dfrac{[9+3-2]-[1+1-2]}{3-1} = 5$ m/s

Q3] $v_f^2 - v_i^2 = 2a\Delta x \Rightarrow 0 - v_i^2 = -2|a|\Delta x$ ← for deceleration.

$\therefore \Delta x = \dfrac{v_i^2}{2|a|} = D$

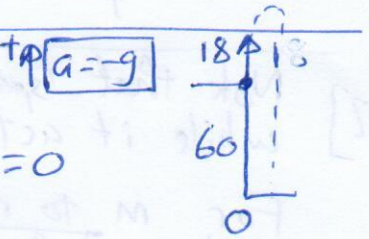
$v_i \to 2v_i \Rightarrow \Delta x' = \dfrac{(2v_i)^2}{2|a|} = 4\dfrac{v_i^2}{2|a|} = 4D$

Q4] $y_f - y_i = v_i t - \frac{1}{2}gt^2$

$-60 = 18t - 4.9t^2 \Rightarrow 4.9t^2 - 18t - 60 = 0$

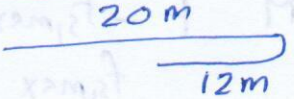
$t = \dfrac{18 \pm \sqrt{(18)^2 - 4(4.9)(-60)}}{2\times 4.9} \Rightarrow t \sim 5.8$ s

(ignore negative answer)



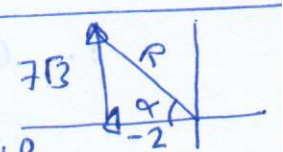
Q5] total distance $= 20 + 12 = 32$ m.

$\bar{s} = \dfrac{\text{total distance}}{\text{total time}} = \dfrac{32}{} \simeq 5.3$ m/s



Q6] $A_x = 5$, $A_y = 0$ | $B_x = -14\cos 60 = -7$, $B_y = 14\sin 60 = 7\sqrt{3}$ | $R_x = -2$, $R_y = 7\sqrt{3}$ | $\tan\alpha = \left|\dfrac{7\sqrt{3}}{-2}\right| \Rightarrow \alpha = 80.6$

$\Rightarrow \theta = 180 - \alpha = 99.4^\circ$



Q7] $\rightarrow +$ $F - P - f_{Mk} = Ma$ — ①

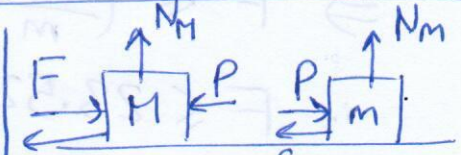
$P - f_{mk} = ma$ — ②

$F - f_{mk} - f_{Mk} = ma \Rightarrow 25 - M_k 6g - M_k 4g = 10a$

$\Rightarrow 25 - 19.6 = 10a \Rightarrow a = 0.54$ m/s^2

using ② $P = M_k(4g) + 4a$

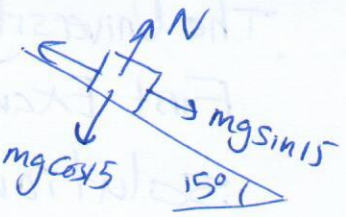
$P = 10$ Newtons



Q8] $f_{s,max} = \mu_s(mg\cos 15) \simeq 7.57$ Newton

$mg\sin 15 \simeq 5.07$

$f_{s,max} > mg\sin 15 \Rightarrow$ object does NOT move $\Rightarrow a = 0$

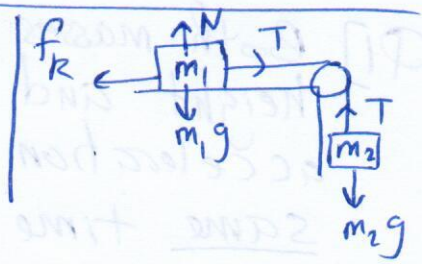


Q9] $\downarrow$ for m_2 $\quad m_2g - T = m_2a$

$\rightarrow$ for m_1 $\quad T - f_k = m_1a$

$\Rightarrow m_2g - f_k = (m_1+m_2)a$

$$a = \frac{m_2g - \mu_k(m_1g)}{m_1+m_2} \simeq 2.6 \text{ m/s}^2$$



Q10] $\Delta K + \Delta U = W_{nc}$ F and F_k are non-conservative forces

$\frac{1}{2}(20)(9-0) + 0 = W_F + W_{f_k} = (120)(8)\cos(0) + W_{f_k}$

$90 = 960 + W_{f_k} \Rightarrow W_{f_k} = 90 - 960 = -870$ J.

Q11] $\Delta K = W_{Total} =$ Area under $F_x - x$ graph.

$\frac{1}{2}(2)(v_f^2 - 9) = 4\times 6 + \frac{1}{2}(2)(6) + \frac{1}{2}(2)(-6) + \frac{1}{2}(2)(-6)$

$v_f^2 - 9 = 24 + 6 - 6 - 6 = 18 \Rightarrow v_f = \sqrt{27} \sim 5.2$ m/s

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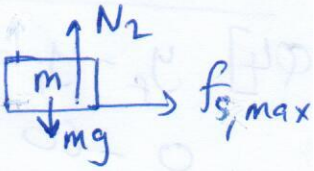
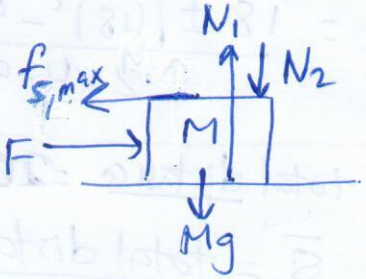
Q12] Note that $f_{s,max}$ acts on m to the right while it acts on M to the left.



For m to move with M without sliding $\boxed{f_{s,max} \geq ma} \Rightarrow a \leq \frac{f_{s,max}}{m}$



$\rightarrow$ + for M $\quad F - f_{s,max} = Ma$ — ①

$f_{s,max} = ma$ — ②

$F = (m+M)a$

$\therefore a = \frac{F}{m+M} \leq \frac{f_{s,max}}{m}$

$\Rightarrow F \leq \left(\frac{m+M}{m}\right) f_{s,max} = \left(\frac{2+4}{2}\right)(\mu_s mg) = \left(\frac{6}{2}\right)(0.4\times 2\times 9.8)$

$\therefore F \leq 23.52$

$\Rightarrow$ max. value for F is 23.52 Newton.