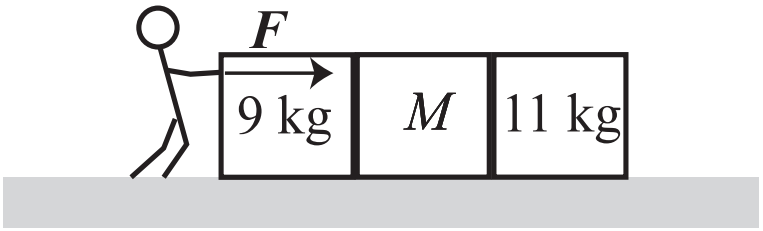
Physics 101 (S11) **Q3A**

Name: _____ **Section:** _____ **Score:** _____/20

1. There are three boxes on a horizontal frictionless floor as illustrated below. A person pushes the leftmost box to the right with a force $\boldsymbol{F}$. The boxes move together.



(a) The force exerted by the rightmost box of mass 11 kg on the middle box is 750 N. What is the acceleration of the middle box? [5]

(b) While keeping $\boldsymbol{F}$, if M is tripled (i.e., $M \to 3M$), then the acceleration of the boxes are halved. What is the mass M? [5]

(**2** on the next page)

2. A box of mass M is on a rough horizontal surface with the coefficient of static friction μ_s and that of kinetic friction μ_k ($< \mu_s$).

(a) Write down the (magnitude of the) maximum force F_M you can horizontally apply to the box without moving it in terms of the symbols given in this problem and the acceleration of gravity g (if needed). [5]

(b) Suppose the block starts to move with the above force F_M, what is its acceleration a of the box? Assume that you keep pushing with F_M even after the box starts to move. Write down a in terms of μ_s, μ_k and g. [5]

Physics 101 (S11) **Q3B**

Name: _____ **Section:** _____ **Score:** _____**/20**

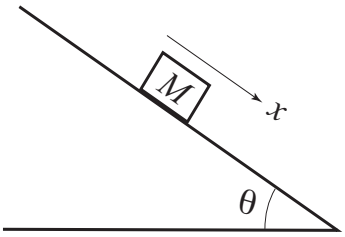
1. A person is on a scale in an elevator. When the elevator is vertically descending at a constant speed 8 m/s, the reading of the scale is 55 kg. Then, the elevator is under a uniform acceleration, and the reading of the scale is 60 kg.

(a) What is the (magnitude of the) acceleration of the elevator? [5]

(b) After 2 seconds of uniform acceleration discussed in (a), the elevator restores its constant velocity vertical motion. What is its velocity? [5]

(**2** on the next page)

2. On an inclined surface with the coefficient μ_s of static friction is a block of mass M as illustrated in the following figure. The block does not spontaneously slide down the slope if the angle θ is not larger than 45°.



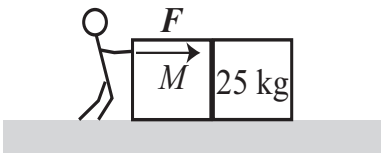
(a) Suppose the angle $\theta = 30°$. Write down the magnitude of the frictional force f on the box from the inclined surface symbolically in terms of M, μ_s, and the acceleration of gravity g; you need not use all of them. [5]

(b) Now, oil is applied on the inclined surface. If the box is gently pushed downward, it slides down the slope with a constant speed. What is the coefficient of kinetic friction? Assume that $\theta = 30°$. [5]

Physics 101 (S11) **Q3C**

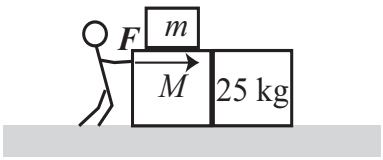
Name: _____ **Section:** _____ **Score:** _____**/20**

1. There are two boxes on a horizontal frictionless floor as illustrated below. A person pushes the left box to the right with a force $\boldsymbol{F}$. The boxes starts to move together.



(a) The force exerted by the right box of mass 25 kg on the left box is 590 N. What is the acceleration of the left box? [5]

(b) Now, a block of mass $m = 10$ kg is put on the left box. With the same force $\boldsymbol{F}$ as before (as in (a)), can the acceleration become 2/3 of that for the case in (a)? You must justify your answer. [Hint: try to compute M.] [5]



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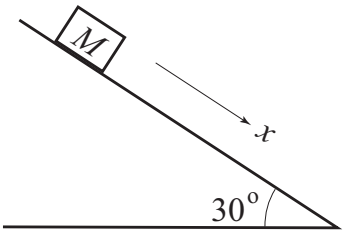
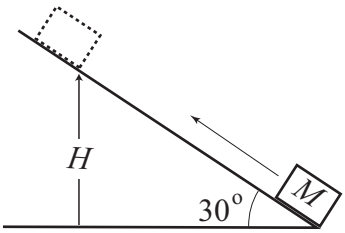
2. On a frictionless inclined surface is a block of mass M as illustrated in the following figure.



(a) Write down the magnitude of the normal force from the plane acting on the block in terms of M and g? [5]

(b) Initially, the block is given a velocity of magnitude 2.3 m/s along the slope in the uphill direction (in the negative x-direction in the figure above) from the bottom of the slope. What is the maximum **height** H (above the floor; see the figure blow) that the block can reach? [5]



Physics 101 (S11) **Q3D**

Name: _____ **Section:** _____ **Score:** _____**/20**

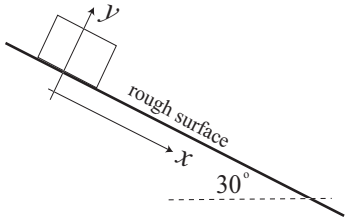
1. Two astronauts A and B have, respectively, the mass M and m.

(a) While floating freely in space, Astronaut A with mass M pushes Astronaut B with a force whose magnitude is F. What is the ratio a_A/a_B of the magnitude of the accelerations a_A and a_B of Astronaut A and B, respectively? [5]

(b) Actually, $a_A/a_B = 1.7$. They reach an extrasolar planet, and start to fall to it. What is the ratio g_A/g_B of the magnitude of the acceleration g_A and g_B due to the pull of the planet of Astronaut A and B, respectively? [5]

(**2** on the next page)

2. A box of mass M is on a rough slope making 30° with the horizontal as illustrated below. The initial velocity $\boldsymbol{v}_0$ is along the x-axis upward (in the negative x-direction). The coefficient of static friction of the surface is $\mu_s = 0.8$ and that of kinetic friction is $\mu_k = 0.2$.



(a) The box comes to a halt after 2.5 s. What is the initial speed v_0? [5]

(b) After initially halting, as in part (a), does the block slide back down the plane? Justify your answer with a calculation. Also, specify the x-coordinate of the block after a total of 10 s, assuming the block started at $x = 0$ m.[5]