2018-2019 Term 2

PHYS1001 Essential Physics

Assignment 2

Due date: 12th Feb, 2019 by 6:00 pm

(Please leave your homework in the box with the label "PHYS 1001" outside room 213 in Science Centre North Block)

Please answer **all** four questions

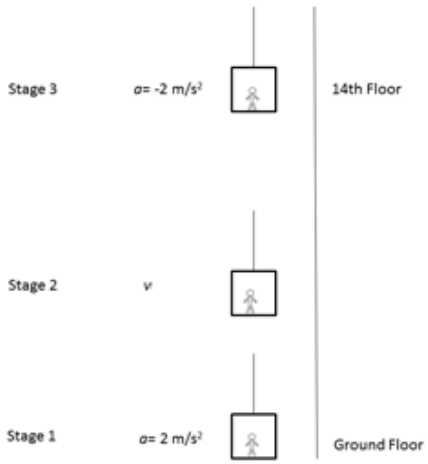
1. A 10 kg block is moving on a smooth horizontal ground with a velocity of 2m/s. A constant force F is applied horizontally to the block for 4 second until it comes to complete stop. Ignore friction in your calculation.
   (a) Estimate the force applied on the block.
   (b) Calculate the displacement of the block.

   Answer:

   (a) $$F = ma$$
   $$F = (10)(0-2)/4$$
   $$F = -5\ ms^{-2}$$

   (b) $$v^2 = u^2 - 2as$$
   $$(0)^2 = 2^2 - 2(-0.5\ )s$$
   $$s = 4\ \text{m}$$

2. John with a mass of 70 kg travels from the ground floor to the 14th floor of a building by a lift. The motion of the lift is described by three stages as shown in the figure below. In the first stage, the lift starts accelerating upwards at 2 ms^{-2} for 3 s. This is followed by stage two in which the lift travels at a constant velocity v. In stage 3, the lift decelerates upwards at 2 ms^{-2} before it stops.



(a) Draw a free body diagram for John while he is in the elevator. Label all the force that act on John. Please also define the positive direction.

(b) Calculate the velocity v at stage 2.

(c) Using the results in (a), write down an expression relating the normal reaction, John's weight and the net force on John. Calculate the net force on John in (i) stage 1, (ii) stage 2, (iii) stage 3 and (iv) when the rope pulling the lift suddenly breaks (i.e. free fall).

(d) John tries to measure his mass using an electronic balance in the lift journey. What is the measured value M_{apparent} in (i) stage 1, (ii) stage 2, (iii) stage 3 and (iv) when the rope pulling the lift suddenly breaks (i.e. free fall).

Answers:

(a) Assuming upward positive

Stage 2

(b) $v = u + at = 0 + 2(3) = 6$ ms^{-1}

(c) (i) $F_{net} = ma = (70)(2) = 140$ N

(ii) $F_{net} = ma = (70)(0) = 0$ N

(iii) $F_{net} = ma = (70)(-2) = -140$ N

(iv) $F_{net} = ma = (70)(-9.8) = -686$ N

(d) From (a) and Newton second law, define upward positive, the Fnet can be written as

$$F_{net} = N - W$$

The weight measured is the normal reaction force, N

$$N = F_{net} + W$$

$$M_{apparent} = \frac{N}{g} = m(a/g + 1)$$

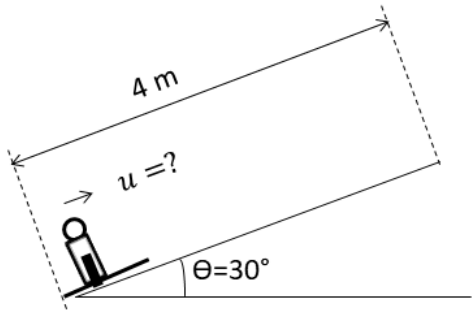
(i) $M_{apparent} = (70)(\frac{2}{9.8} + 1)$=84.29 kg

(ii) $M_{apparent} = (70)(0 + 1) = 50$ kg

(iii) $M_{apparent} = (70)\left(-\frac{2}{9.8} + 1\right)$ =55.7kg

(iv) $M_{apparent} = (70)\left(-\frac{9.8}{9.8} + 1\right) = 0$ kg

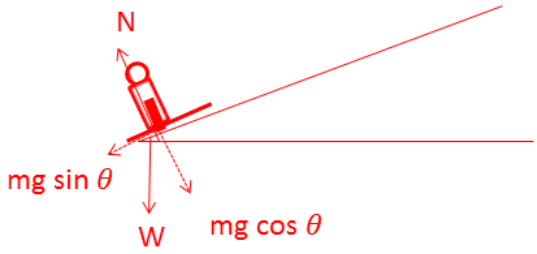
3. James with a mass of 80 kg is trying to ski uphill with an unknown initial velocity u. He skis for a length of slope is 4 m before he stops. The angle between the slope and the ground is 30°.



(a) Draw a force diagram for James while he is on the slope.
(b) Calculate the value of the normal reaction force.
(c) Calculate the minimum initial velocity required to reach to top of the slope.

Answers:

(a)



(b) The weight in the direction perpendicular to the plane is equal to $mg\cos\theta$ according to the above diagram. By applying Newton's second law in the direction perpendicular to the inclined plane,

$$N = mg\cos\theta$$
$$N = (80)(9.81)\cos 30°$$
$$N = 679.7 \text{ N}$$

The normal force is 679.7 N.

(c) The component of the weight along the inclined plane is $mg\sin\theta =$ $(80)(9.81)\sin 30°$=392.4 N. The acceleration in the direction parallel to the plane is

$$F_{net} = ma$$
$$-mg\sin\theta = ma$$
$$a = -g\sin\theta$$
$$a = -(9.81)\sin 30°$$
$$a = -4.905 \text{ ms}^{-2}$$

$$v^2 = u^2 + 2as$$
$$0^2 = u^2 + 2(-4.905)(4)$$
$$u = 4.43 \text{ m/s}$$

4. Students A and B, with the mass of students A larger than that of student B, are initially at rest standing in an ice rink. The two students face each other and then push against each other. Consequently, they move in opposite direction. Using Newton's third law of motion, explain which student will move with a higher speed. Assume there is no friction between the shoes of the students and the ice.

   Answers:

   According to Newton's third law, the force acting on each student has the same magnitude but the two forces point in opposite direction. Since student B is lighter than student A, student B experienced a higher acceleration and thus moves with a higher final speed.