The impact of scaffolding on learning physics: is there a gender difference?

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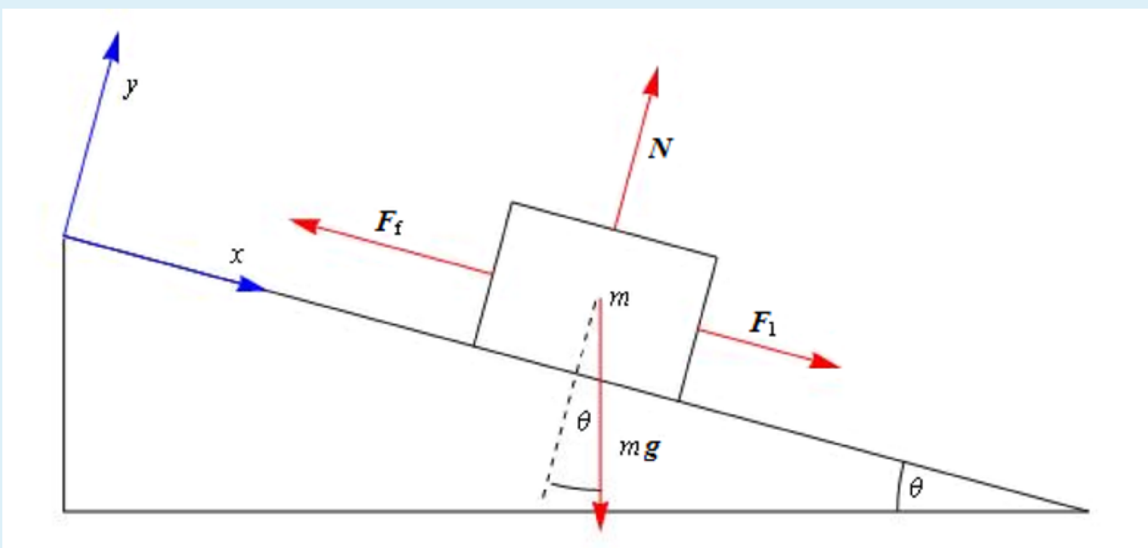
Goals:

1. Identify elements of question structure which may be disadvantaging female students
2. Test the use of scaffolding as a potential solution

Identifying bias:

What do these questions have in common?

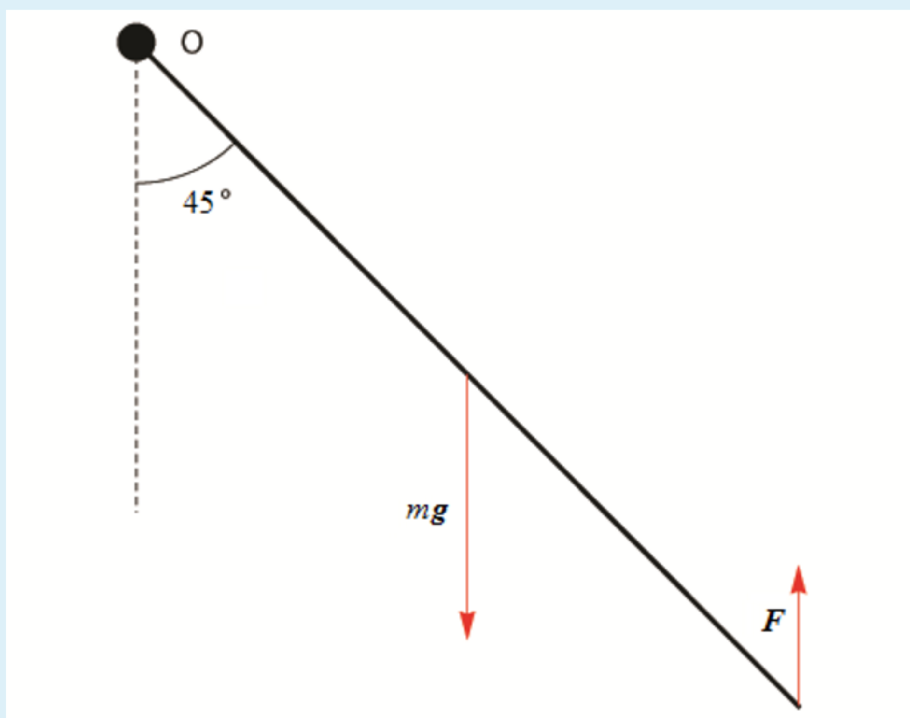
The diagram shows a block of mass $m = 4.50\ \mathrm{kg}$ resting on a plane inclined at an angle of $\theta = 30°$ to the horizontal. The coefficient of static friction between the block and the plane is $\mu_{static} = 0.635$, and the block is stationary but just on the point of sliding down the slope.



The diagram shows the four forces acting on the block: an applied force $\boldsymbol{F}_1$ acting down the slope, the block's weight $m\boldsymbol{g}$, the normal reaction force $\boldsymbol{N}$ and the force of static friction, $\boldsymbol{F}_f$. In this case, the force of static friction acts up the slope, opposing the tendency of the block to move down the slope.

Find the the maximum magnitude of the applied force $\boldsymbol{F}_1$ that can be exerted if the block is to remain stationary. Specify your answer by entering a number into the empty box below.

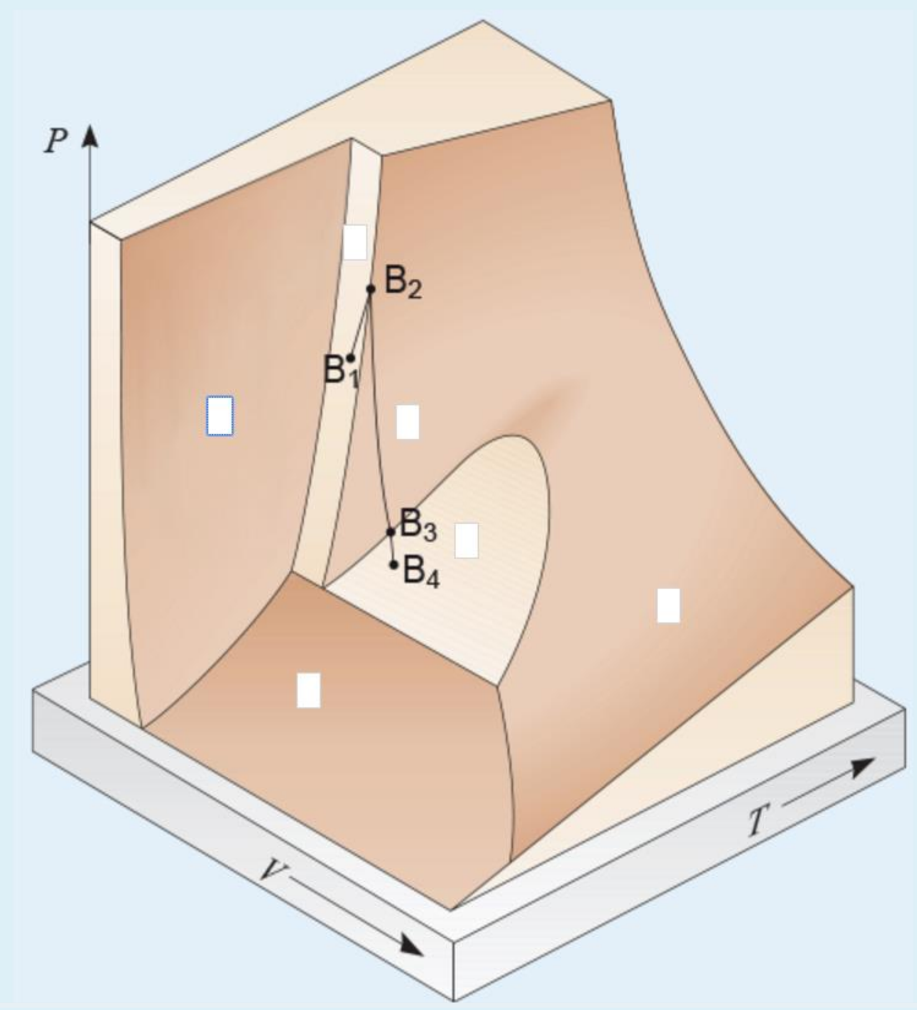
A uniform rod has mass m and length L. One end of the rod is attached to a fixed point O by a hinge and an additional force $\boldsymbol{F}$ is applied to the other end of the rod in the vertical direction shown.



Given that the rod is in mechanical equilibrium, what is the magnitude of the applied force $\boldsymbol{F}$, expressed as a numerical multiple of mg, where g is the magnitude of the acceleration due to gravity? Express your answer by entering a decimal number, specified to 3 significant figures, into the empty box below.

The figure below shows a generic PVT surface – drag and drop the ✓ below to show the three areas on the diagram where the substance is totally or partially in the liquid phase. (Note that you will need to fill 3 boxes on the diagram and leave the remaining boxes empty in this part of the question.)

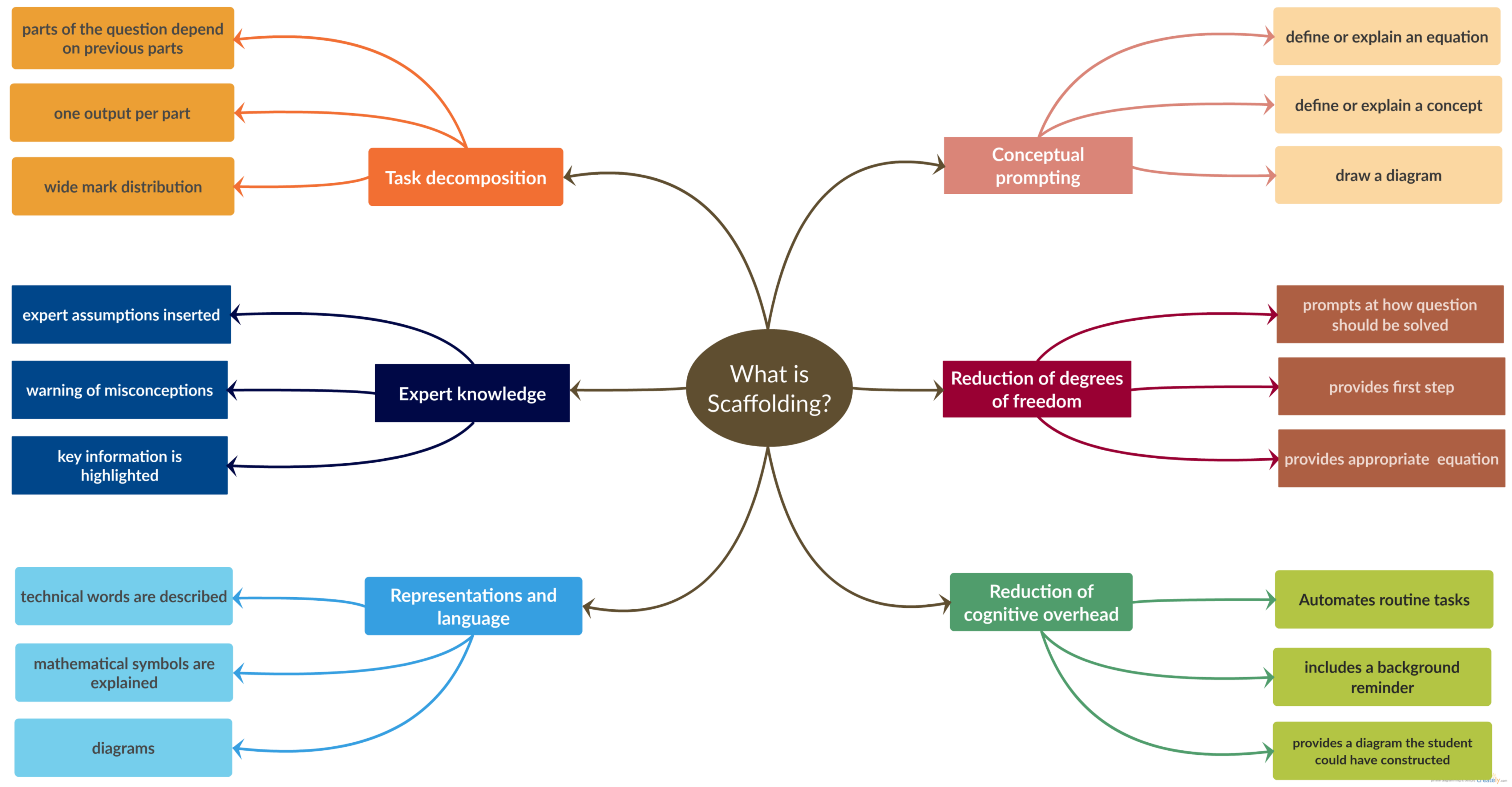
✓



Complete the following statement describing features shown on the generic PVT surface in the figure by dragging each word from the list and dropping it into the most appropriate space. Each word in the list may be used once, more than once and some words may not be used at all.

Each point on a generic PVT surface corresponds to a combination of the pressure, volume and temperature values that can be achieved for a fixed amount of the substance in ____. The path $B_1 \rightarrow B_4$ lies on the generic PVT surface and hence consists of a series of ____ processes. At B_1 the substance is a mixture of ____ and ____ in equilibrium. Although ____ is increasing substantially along the line $B_1 \rightarrow B_2$ both ____ and ____ also increase so that at B_2 the mixture is entirely ____. ____ decreases quite substantially along the line $B_2 \rightarrow B_3$ and at B_3 the liquid begins to ____. So from B_3 to B_4 there is a mixture of ____ and ____ in equilibrium with ____ and ____ reducing and ____ increasing.

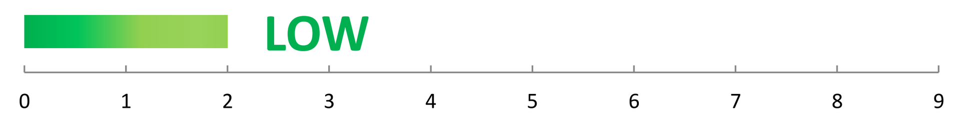
solid	liquid	temperature	volume	pressure	melt
gas	evaporate	condense	quasistatic	equilibrium	



Addressing bias:

Can scaffolding play a role?

Q1 Scaffolding level:



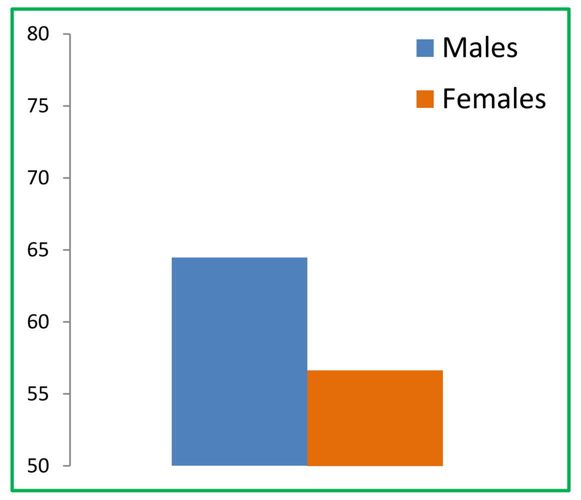
An astronaut playing golf on the Moon hits a ball so that it is initially moving with a speed of $u = 8.00\ \mathrm{m\ s^{-1}}$ at an angle of $\theta = 30°$ to the horizontal. In the following, the magnitude of the acceleration due to gravity at the Moon's surface, g_M, is approximately $1.62\ \mathrm{m\ s^{-2}}$.

(a) Make sketches of the vertical components of displacement, s_y, and velocity, v_y, versus time, t. Label the sketches with appropriate equations for s_y and v_y.

(*6 marks*)

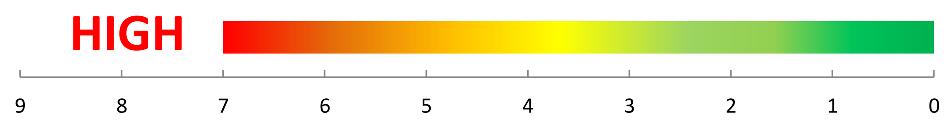
(b) Assuming the surface of the Moon is flat in the vicinity of the astronaut, calculate how far the ball travels.

(*4 marks*)



A significant difference
p = .013

Q2 Scaffolding level:



An athlete competing in the hammer throw event swings a heavy metal ball on a wire around in a circle. The radius of the circle that the ball travels is $1.5\ \mathrm{m}$ and the ball takes $0.55\ \mathrm{s}$ to complete one revolution.

(a) Calculate the *magnitude* of the instantaneous velocity of the ball and state the *direction* of the velocity at any instant, relative to the circle.

(2 marks)

At the instant when the velocity of the ball is in a direction at $50°$ to the horizontal, moving upwards, the ball is released. At this instant, the ball is $2.0\ \mathrm{m}$ above the ground, as shown in Figure 2.

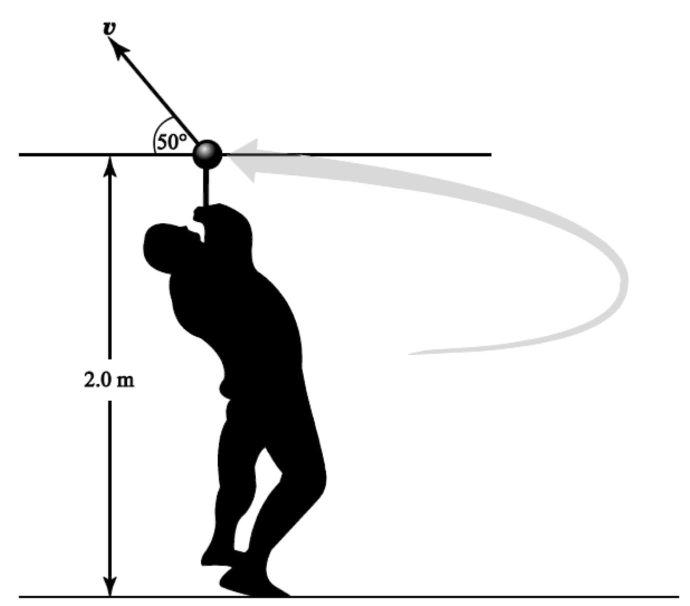


Figure 2 For use with Q20.

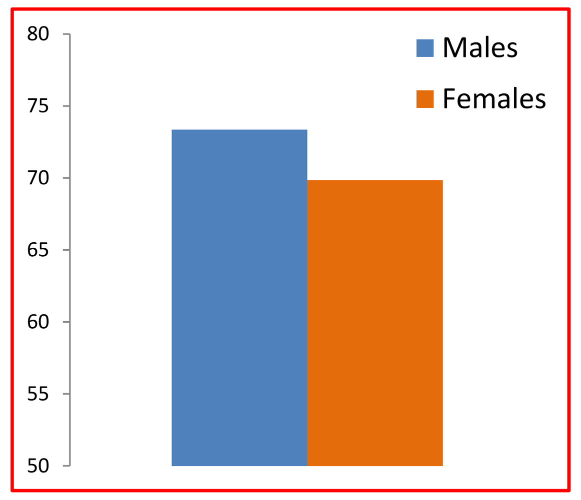
(b) What are the horizontal (x) and vertical (y) components of the ball's velocity at the instant when it is released?

(3 marks)

(c) What is the maximum height above the ground attained by the ball during its flight?

(5 marks)

(You may assume that the magnitude of the acceleration due to gravity is $9.8\ \mathrm{m\ s^{-2}}$ and you may ignore air resistance.)



Not a significant difference
p = .46