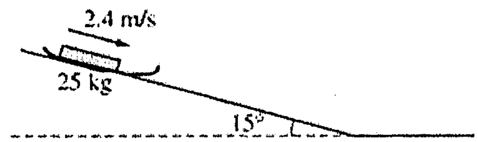


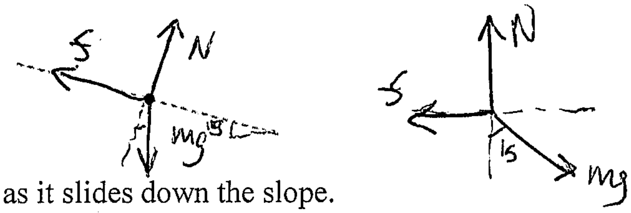
6. An empty sled of mass 25 kg slides down a muddy hill with a constant speed of 2.4 m/s. The slope of the hill is inclined at an angle of 15° with the horizontal as shown in the figure above.

a. Calculate the time it takes the sled to go 21 m down the slope.

$$X = Vt$$

$$t = \frac{X}{V} = \frac{21}{2.4} = 8.75\ s$$

b. On the dot below that represents the sled, draw/label a free-body diagram for the sled as it slides down the slope



c. Calculate the frictional force on the sled as it slides down the slope.

$$x)\quad mg\sin 15 - f = 0 \leftarrow \text{constant speed} \quad a = 0$$

$$f = mg\sin 15 = \boxed{64.7N}$$

d. Calculate the coefficient of friction between the sled and the muddy surface of the slope.

$$f = \mu N \qquad y)\ N - mg\cos 15 = 0 \qquad \mu = \frac{f}{N} = \frac{64.7}{241.5}$$

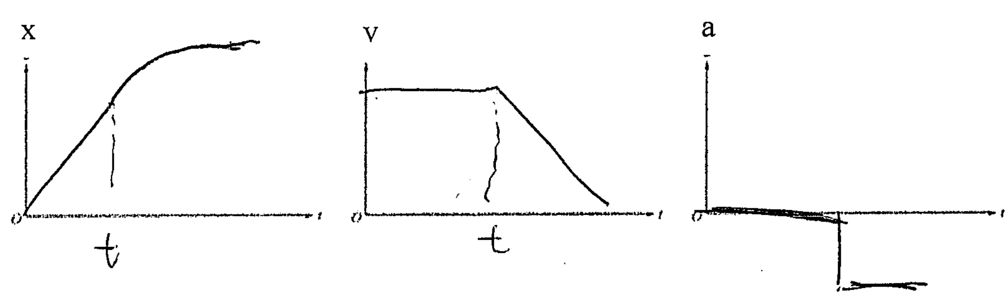
$$N = 241.5\ N \qquad \boxed{= .27}$$

e. The sled reaches the bottom of the slope and continues on the horizontal ground. Assume the same coefficient of friction.

i. In terms of velocity and acceleration, describe the motion of the sled as it travels on the horizontal ground.

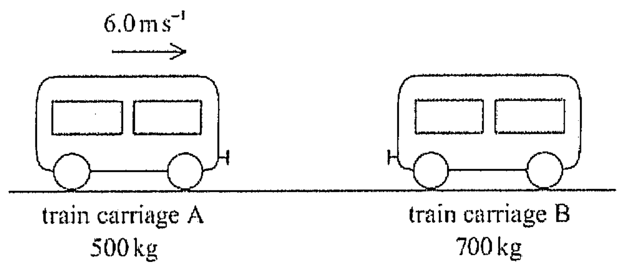
The sled has a decreasing velocity and a constant negative acceleration.

ii. On the axes below, sketch a graph of the x-t, v-t, and a-t. Clearly indicate with the symbol the time at which the sled leaves the slope.



7.

A train carriage A of mass 500 kg is moving horizontally at 6.0 m s^{-1}. It collides with another train carriage B of mass 700 kg that is initially at rest, as shown in the diagram below.

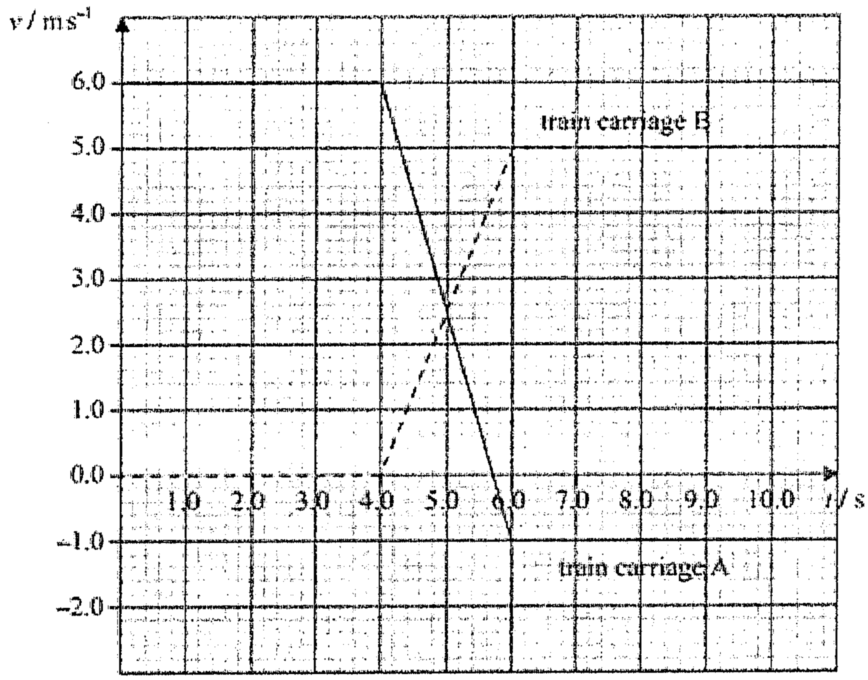


The graph below shows the variation with time t of the velocities of the two train carriages before, during and after the collision.

A

$V_0 = 6 \frac{m}{s}$

$V_f = -1 \frac{m}{s}$



B

$V_0 = 0 \frac{m}{s}$

$V_f = 5 m/s$

(a) Use the graph to deduce that

(i) the total momentum of the system is conserved in the collision.

$P_0 = 500(6)$

$= 3000 \text{ kg} \frac{m}{s}$

$P_f = 500(-1) + 700(5)$

$P_f = 3000 \text{ kg } m/s$

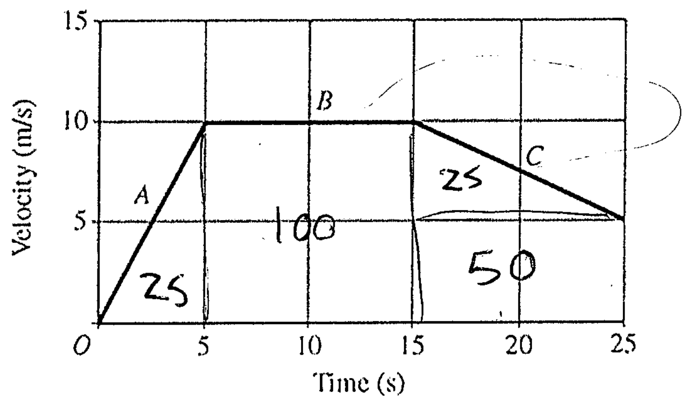
(b) Calculate the magnitude of the average force experienced by train carriage B.

$F = ma$

$a =$ slope of v-t

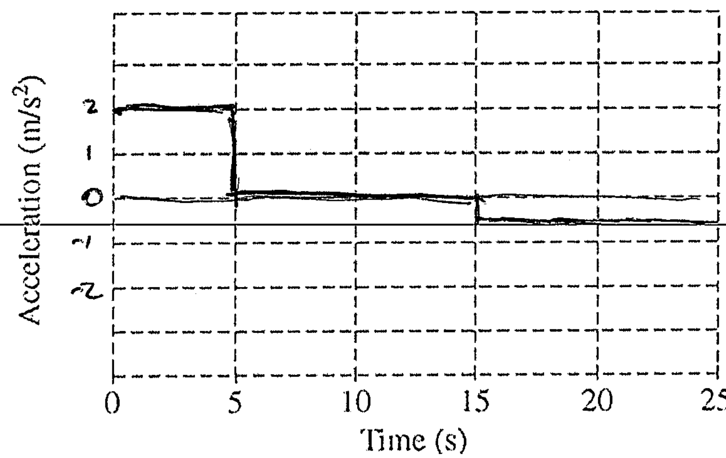
$\frac{5 \, m/s}{2 \, s} = 2.5 \, m/s$

$F = 700(2.5) = \boxed{1750 N}$



8. A 0.40 kg object moves in a straight line under the action of a net force. The graph above shows the velocity as a function of time for the object during a 25 s interval. At time $t = 0$, the object is at the position $x = 0$.

(a) On the grid below, sketch a graph of the acceleration as a function of time for the object. Label the scale for the acceleration.



← slope of the V-t graph

(b) Calculate the position of the object at $t = 5.0$ s. Area of V-t graph 25 m

(c) On which segment of the graph is the net force acting on the object zero?

____ A X B ____ C No accel means no force

Justify your answer.

slope from 0-5 sec

(c) Calculate the net force on the object during the first 3.0 s of the motion. $F = ma$ $F = 0.4(2) = \boxed{0.8N}$

(d) Calculate the amount of work done on the object by the net force during the first 15 s of the motion.

(e) For the interval $t = 15$ s to $t = 25$ s, is the work done on the object by the net force positive, negative, or zero?

____ Positive X Negative ____ Zero Justify your answer.

D) I W F K

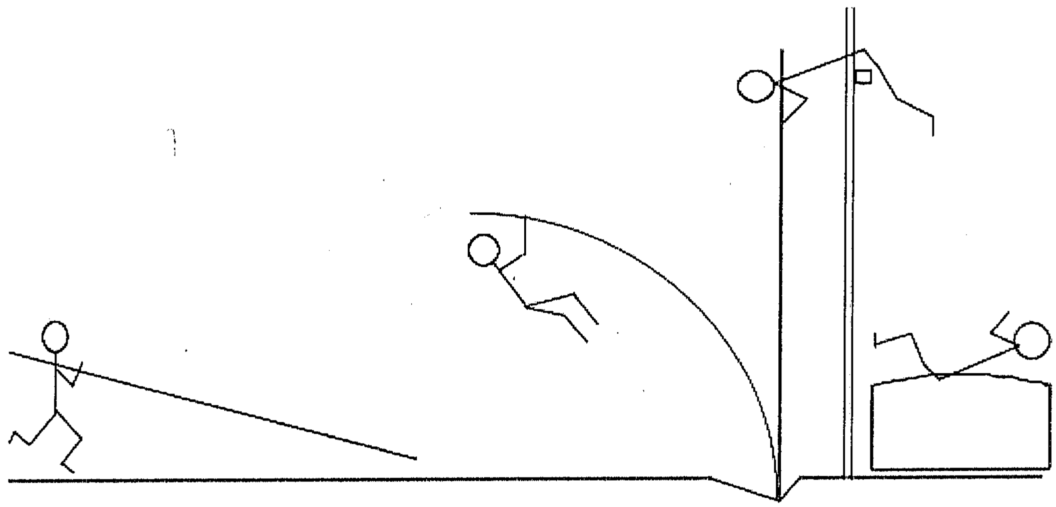
$W = \frac{1}{2}mv^2$

$W = \frac{1}{2}(.4)10^2 = 20J$

E) The object slows down so the work is negative.

9.

In the pole vault event an athlete runs as fast as possible towards the bar, holding a flexibl fibreglass pole. He sticks the end of the pole into a slot in the ground, swings up on the pole an over the bar as shown (not to scale).



(a) Describe the energy transformations that occur for the athlete and the pole during the event.

(b) A good athlete can reach a maximum running speed of about 9 m s^{-1} carrying the pole. Estimate the maximum bar height over which a pole vaulter can vault. Assume that the athlete's mass can be taken as concentrated at his 'centre of mass' roughly at the centre of his body. Omit any work done as the vaulter pulls or pushes on the pole during the vault. State any other assumptions or simplifications you make.

A) The energy starts as kinetic, Then as the pole is put into the slote the energy transforms into spring and potential energy. Later the energy is all potential (at the top). After falling from the top the energy turns to kinetic.

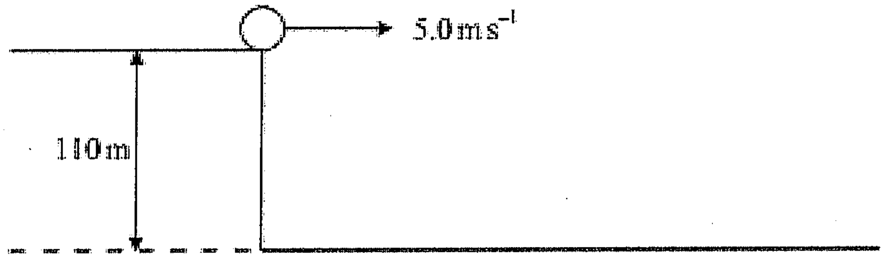
B) $\frac{1}{2}mv^2 = mgh$

$\frac{1}{2}9^2 = 10h$

$h = 4.05m$

10.

A ball is projected horizontally at $5.0\,\mathrm{m\,s^{-1}}$ from a vertical cliff of height 110 m. Assume that air resistance is negligible and use $g = 10\,\mathrm{m\,s^{-2}}$.

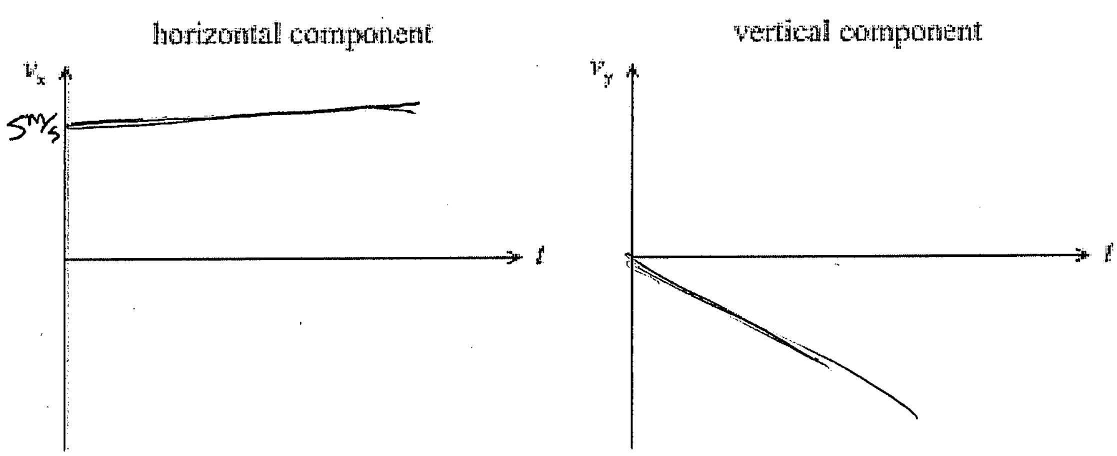


(not to scale)

(a) (i) State the magnitude of the horizontal component of acceleration of the ball after it leaves the cliff. [1]

There is no horizontal acceleration.

(ii) On the axes below, sketch graphs to show how the horizontal and vertical components of the velocity of the ball, v_x and v_y, change with time t until just before the ball hits the ground. It is not necessary to calculate any values. [2]



(b) (i) Calculate the time taken for the ball to reach the ground. [2]

$y = \frac{1}{2} a t^2$

$110 = \frac{1}{2}(10) t^2$

$t = \sqrt{22} = \boxed{4.7s}$

$x = x_0 + V_0 t + \frac{1}{2} a t^2$

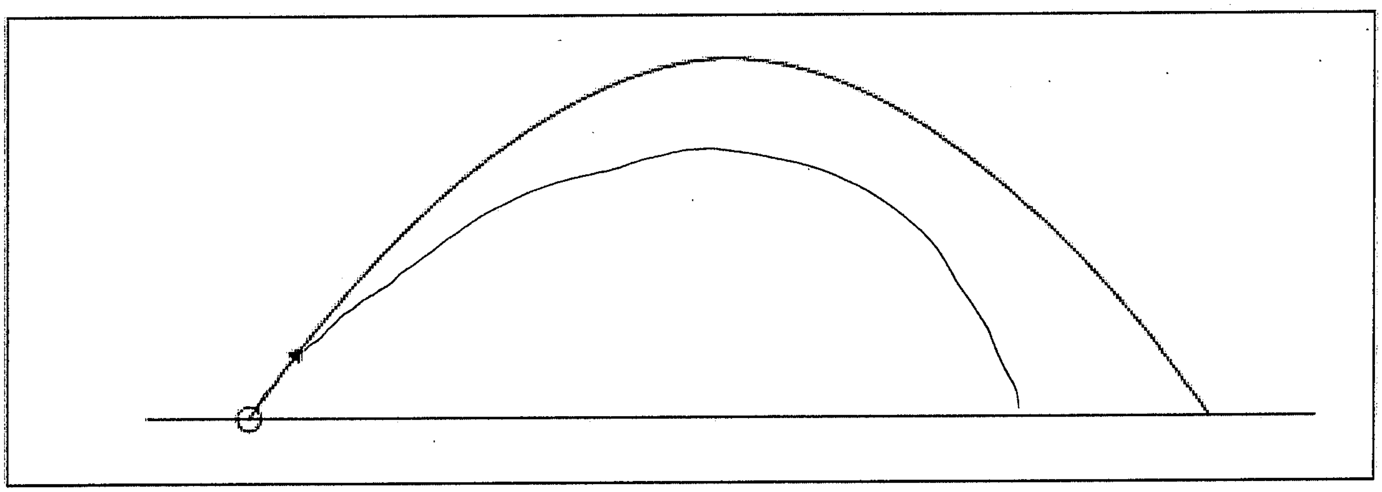
(ii) Calculate the horizontal distance travelled by the ball until just before it reaches the ground. [2]

$X = V_0 t$

$x = 5(4.7)$

$\boxed{= 23.5m}$

(c) Another projectile is launched at an angle to the ground. In the absence of air resistance it follows the parabolic path shown below.



On the diagram above, sketch the path that the projectile would follow if air resistance were not negligible. [3]