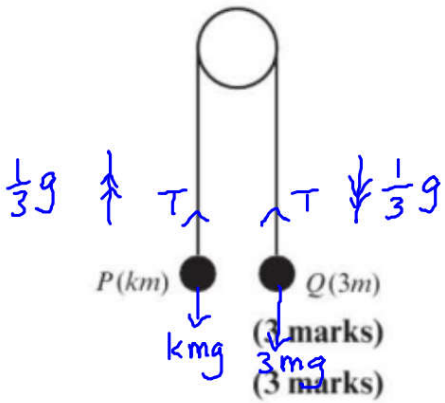
2 Two particles P and Q have masses km and $3m$ respectively, where $k < 3$. The particles are connected by a light inextensible string which passes over a smooth light fixed pulley. The system is held at rest with the string taut, the hanging parts of the string vertical and with P and Q at the same height above a horizontal plane, as shown in the diagram. The system is released from rest. After release, Q descends with acceleration $\frac{1}{3}g$.



a Calculate the tension in the string as Q descends. **(3 marks)**

b Show that $k = 1.5$ **(3 marks)**

c State how you have used the information that the pulley is smooth. **(1 mark)**

a) R↓, F=ma, Q

$3mg - T = 3m \times \frac{1}{3}g$

$3mg - T = mg$

$T = 2mg$

b) R↑, F=ma, P

$T - kmg = km \times \frac{1}{3}g$

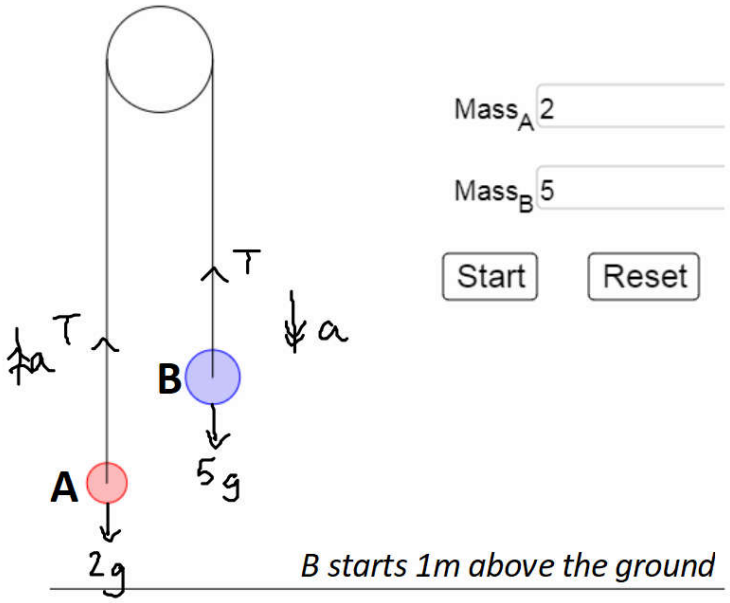
$2mg - kmg = \frac{1}{3}kmg$

$2 - k = \frac{1}{3}k$

$2 = \frac{4}{3}k$

$k = \frac{6}{4} = \frac{3}{2} = 1.5$

c) Tension is equal throughout.



After B hits the floor, what happens next?

Can you describe what happens to A?

(describe its acceleration, speed, etc. Use as much mechanics language as possible!)

What is the acceleration of A after they are released?
What is the tension in the string?

B, R↓, F=ma

$5g - T = 5a$ ①

A, R↑, F=ma

$T - 2g = 2a$ ②

$T = 2a + 2g$

① + ②

$5g - T + T - 2g = 5a + 2a$

$3g = 7a$

$4.2 = \frac{3}{7}g = a$

$T = 2 \times 4.2 + 2 \times 9.8$

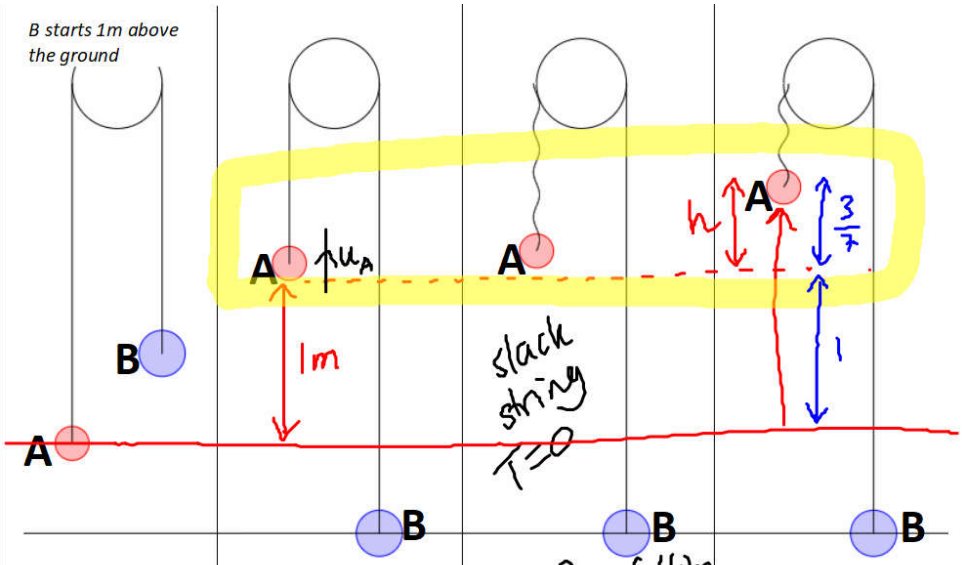
$T = 28\,N$

https://www.geogebra.org/m/fyysxw3s

Checklist

F=ma
F=ma
Solve

SUVAT: v ⇨ u
New acceleration: T = 0
SUVAT
Solve problem



How far does A travel before reaching its greatest height?

$F = ma$, A

$T - 2g = 2a$

But $T = 0$

$-2g = 2a$

$a = -g$

From start to when B hits floor ↑+

$u = 0$

$a = 4.2$

$s = 1$

$v = ?$

$v^2 = u^2 + 2as$

$v^2 = 0 + 2 \times 4.2 \times 1$

$v = \sqrt{8.4}$

	the end of journey	free falling ↗	
$a = 4.2$	$a = 4.2$	$a = -9.8$	$a = -9.8$
$T = 28$	$T = 28$	$T = 0$	$T = 0$
	$u_a = \sqrt{8.4}$		$v_a = 0$

Checklist

- F=ma
- F=ma
- Solve

- SUVAT: v ⇨ u
- New acceleration: T = 0
- SUVAT
- Solve problem

From when B hits floor to A's max height

$a = -9.8$

$u = \sqrt{8.4}$

$v = 0$

$s = ?$

$v^2 = u^2 + 2as$

$0 = 8.4 + 2 \times -9.8 \times s$

$19.6s = 8.4$

$s = \frac{3}{7}$ m

A travels $1 + \frac{3}{7} = 1.43$ m (3sf)

Ex 10F Q1, 2, 3

Checklist
- F=ma ✓
- F=ma ✓
- Solve ✓

SUVAT: v ⇨ u ✓
New acceleration: T = 0 ✓
SUVAT ✓
Solve problem

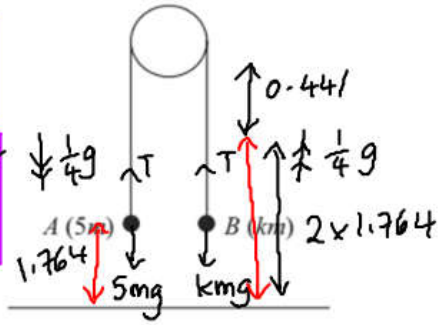


Figure 4

Two particles A and B have masses $5m$ and km respectively, where $k < 5$. The particles are connected by a light inextensible string which passes over a smooth light fixed pulley. The system is held at rest with the string taut, the hanging parts of the string vertical and with A and B at the same height above a horizontal plane, as shown in Figure 4. The system is released from rest. After release, A descends with acceleration $\frac{1}{4}g$.

(a) Show that the tension in the string as A descends is $\frac{15}{4}mg$. **(3)**

(b) Find the value of k. **(3)**

(c) State how you have used the information that the pulley is smooth. **(1)**

Tension equal throughout.

After descending for 1.2 s, the particle A reaches the plane. It is immediately brought to rest by the impact with the plane. The initial distance between B and the pulley is such that, in the subsequent motion, B does not reach the pulley.

(d) Find the greatest height reached by B above the plane. **(7)**

a) A, R↓, F=ma

$5mg - T = 5m \times \frac{1}{4}g$

$5mg - \frac{5}{4}mg = T$

$\frac{15}{4}mg = T$

b) B, R↑, F=ma

$T - kmg = km \times \frac{1}{4}g$

$\frac{15}{4}mg - kmg = \frac{1}{4}kmg$

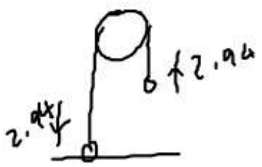
$\frac{15}{4} - k = \frac{1}{4}k$

$\frac{15}{4} = \frac{5}{4}k$

$k = 3$

d) $u = 0$
$t = 1.2$
$a = \frac{1}{4}g = 2.45$
$v = ?$

$v = u + at$
$= 1.2 \times 2.45$
$v = 2.94$



new acceleration is −9.8 (freefall)

$u = 2.94$
$a = -9.8$
$s = ?$
$v = 0$

$v^2 = u^2 + 2as$
$0 = 2.94^2 + 2(-9.8)s$
$19.65 = 2.94^2$
$s = 0.441\text{ m}$

How far above the plane were they?

$s = ?$
$a = 2.45$
$u = 0$
$t = 1.2$

$s = 0 \times 1.2 + \frac{1}{2} \times 2.45 \times 1.2^2$
$s = 1.764$

Total distance above the plane $= 2 \times 1.764 + 0.441$
$= 3.969 = 3.97\text{ m}$ (3sf)