Year 11 Physics Test **_SOLUTIONS_**

Linear Motion and Forces

1. Consider a bowling ball moving at a constant speed of 6.7 ms^{-1} on a flat horizontal surface.

   (a) $v = 6.7 \text{ m/s} \quad s = 18 \text{ m} \quad t = ?$

   $$t = \frac{s}{v} = \frac{18}{6.7} = 2.7 \text{ s}$$

   (b) People walk about about 1 or 2 m/s so probably around 9 to 18 seconds.

2.

   (a) $v_0 = 0 \text{ m/s} \quad v = 21 \text{ m/s} \quad t = 5.3 \text{ s} \quad a = ?$

   $$a = \frac{v - v_0}{t} = \frac{21 - 0}{5.3} = 4.0 \text{ m/s/s}$$

   (b) $v = 0 \text{ m/s} \quad v_0 = 21 \text{ m/s} \quad a = -10 \text{ m/s/s} \quad t = ?$

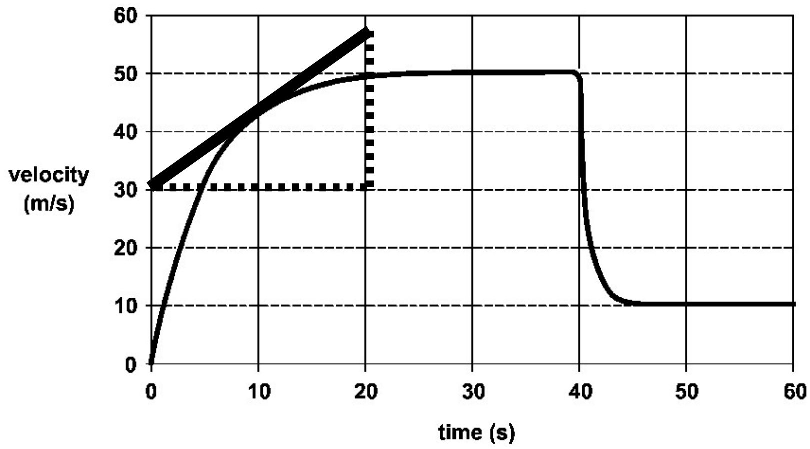
   $$t = \frac{v - v_0}{a} = \frac{0 - 21}{-10} = 2.1 \text{ s}$$

   (c) Average velocity is measured over a period of time (and might change to more or less during that time) whereas instantaneous is just for a single moment.

3.

(a)

(i) Acceleration is gradient (slope of velocity over time)



$$slope = \frac{rise}{run} = \frac{56-30}{20-0} = 1.3\,\text{m/s/s}$$

(ii) $F = ma$

$= 72 \times 1.3$

$= 94$ N

(iii) $F_{weight} = mg$

$= 72 \times 9.8$

$= 7.1 \times 10^2$ N

(iv) $F_{net} = F_{weight} - F_{\text{resistance}}$

$\therefore F_{\text{resistance}} = F_{weight} - F_{net}$

$= 7.1 \times 10^2 - 94$

$= 6.1 \times 10^2$ N

(b) Princess Peach opened her parachute.

4. $v_0 = 0$ m/s/s $\quad s = -1.5$ m $\quad a =$ -9.8 m/s/s $\quad t = ?$

$s = v_0 t + \frac{1}{2}at^2$

$\therefore s = \frac{1}{2}at^2$

$\therefore t = \sqrt{\dfrac{s}{\frac{1}{2}a}}$

$= \sqrt{\dfrac{-1.5}{\frac{1}{2} \times -9.8}}$

$= 0.55$ s

5. $v_0 = 2.3$ m/s/s $\quad v = 0$ m/s/s $\quad a =$ -9.8 m/s/s $\quad s = ?$

$$v^2 = {v_0}^2 + 2as$$

$$\therefore s = \frac{v^2 - {v_0}^2}{2a}$$

$$= \frac{0^2 - 2.3^2}{2 \times -9.8}$$

$$= 0.27 \text{ m}$$

6. Objects have a weight, their downward force due to gravity, which causes them to push downwards on the ground. Newton's 3rd Law state that every force has an equal and opposite reaction force, so when the object pushes the ground down, the ground must push the object up with the same amount of force.

7.

(a) An object's resistance to change in motion.

(b) It will continue at a constant velocity (constant speed, in a straight line).

(c) Astronaut pushes spanner, spanner pushes astronaut.

(d) The astronaut could push the spacecraft in the opposite direction to the direction he throws the spanner, using the same amount of force. The spacecraft will push him in the direction of the spanner, which will cancel out the force of the spanner, giving him a net force of zero.

$\underset{\text{push from spanner}}{\longrightarrow} + \underset{\text{push from spacecraft}}{\longleftarrow}$ $\quad \therefore$ net force is zero, so he doesn't accelerate

8.

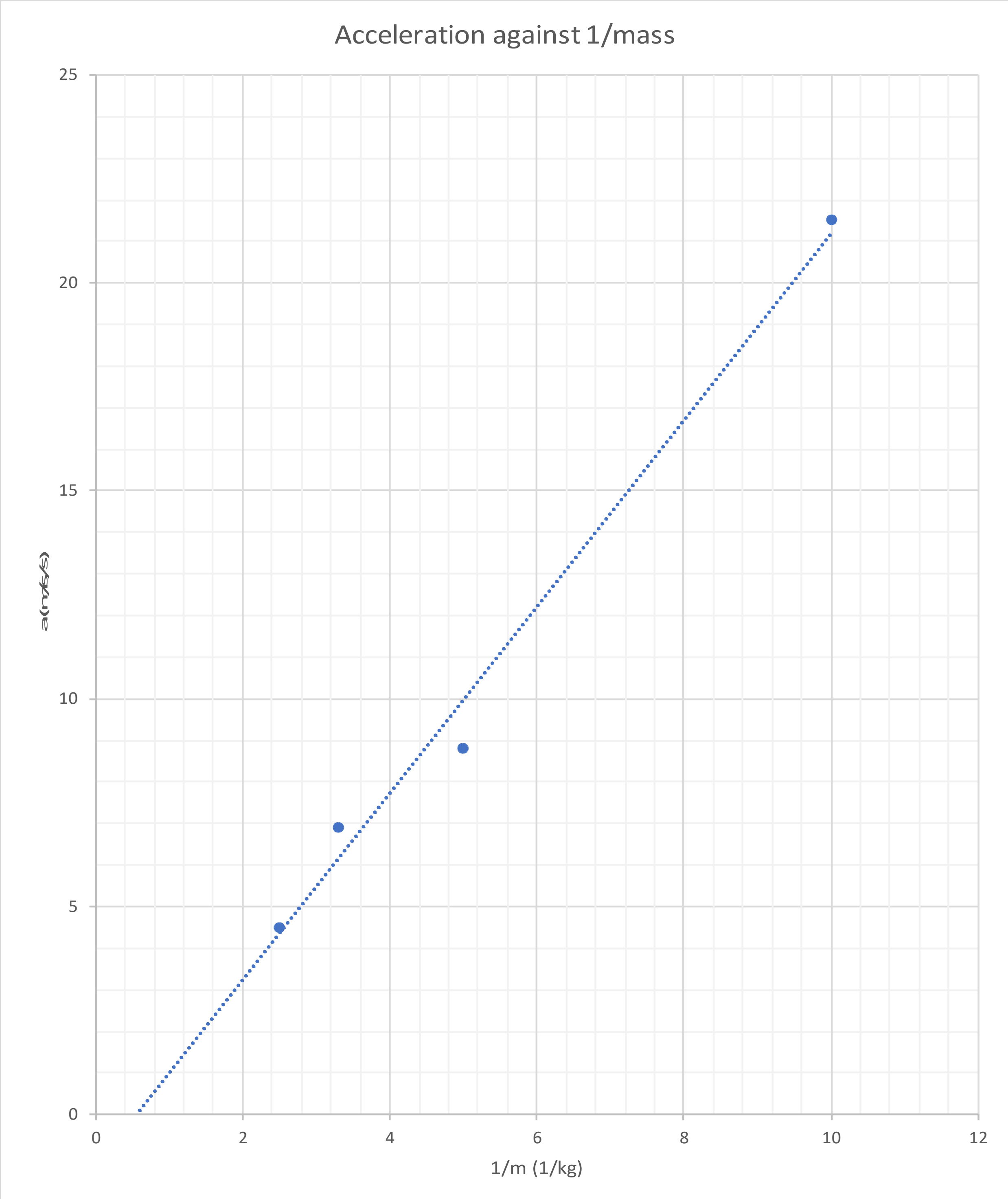
a) The force being applied.

b)

$\frac{1}{m}$ (kg^{-1})
10
5.0
3.3
2.5

c) See next page

d) The data is somewhat reliable as the data points are generally close to the line of best fit. There is obvious scatter (about 1 m/s/s); since this not consistent it indicates the presence of random error. Repeating and averaging measurements would improve the results because they would reduce the effect of random error.



Acceleration against 1/mass
25
20
15
10
5
0
0
2
4
6
8
10
12
1/m (1/kg)

Bonus question:

One possible approach is to consider that the second half of the flight, $\frac{1}{2}t$, is the same amount of time the projectile would take if it was dropped from that height. The speed will be the same as at launch but downwards instead of upwards.

$v_0 = 0 \quad a = -g$

$v = v_0 + at$

$\therefore -v = 0 + -g \times \frac{1}{2}t$

$\therefore v = \frac{1}{2}gt$

$$\therefore g = \frac{2v}{t}$$