

## AS Physics: Taster Questions

Name: \_\_\_\_\_

Attempt all questions. If you get completely stuck, you **must** write a short explanation of **why** you cannot do the question.

These questions are all related to motion. To complete them, you will need the following information and formulae.

SUVAT equations

$$s = \frac{(u+v)t}{2} \quad s = ut + \frac{1}{2}at^2 \quad v = u + at \quad v^2 - u^2 = 2as$$

The following abbreviations are used in the above formulae:

s = distance moved

a = acceleration

u = initial velocity

v = final velocity

t = time taken

If the accelerating force is gravity,  $a = 9.81\text{m/s}^2$

Note: Any formulae used during KS4 are assumed to be prior knowledge and are not given here.

### 1. This question is about the article *Performance of commercial jet aircraft*.

- (a) Use the data on the Airbus A340-600 below to answer the following questions.

type	cruising speed km / h	fuel consumption litre / h	fuel capacity / litre	range / km
Airbus A340-600	902	9800	195 600	13 900

- (i) Show that the plane takes about 15 hours to travel the range at its cruising speed.

[1]

- (ii) Show that the fuel consumed in travelling the range at cruising speed is less than 80% of the maximum fuel carried.

[2]

- (iii) Suggest and explain one reason why the aircraft carries more fuel than that needed to travel its range at its cruising speed.

[2]

- (b) Use the data on the MD-11 below to answer the following questions.

type	number of engines	maximum thrust per engine / N	maximum take-off mass / kg	take off distance / m
MD-11	3	270 000	273 900	3100

- (i) Show that the initial acceleration of the MD-11, with maximum thrust and maximum take-off mass, is approximately  $3 \text{ m s}^{-2}$ .

[2]

- (ii) Use your answer to (b)(i) to calculate the distance required for the MD-11 to reach a take-off speed of  $81 \text{ m s}^{-1}$ .

[2]

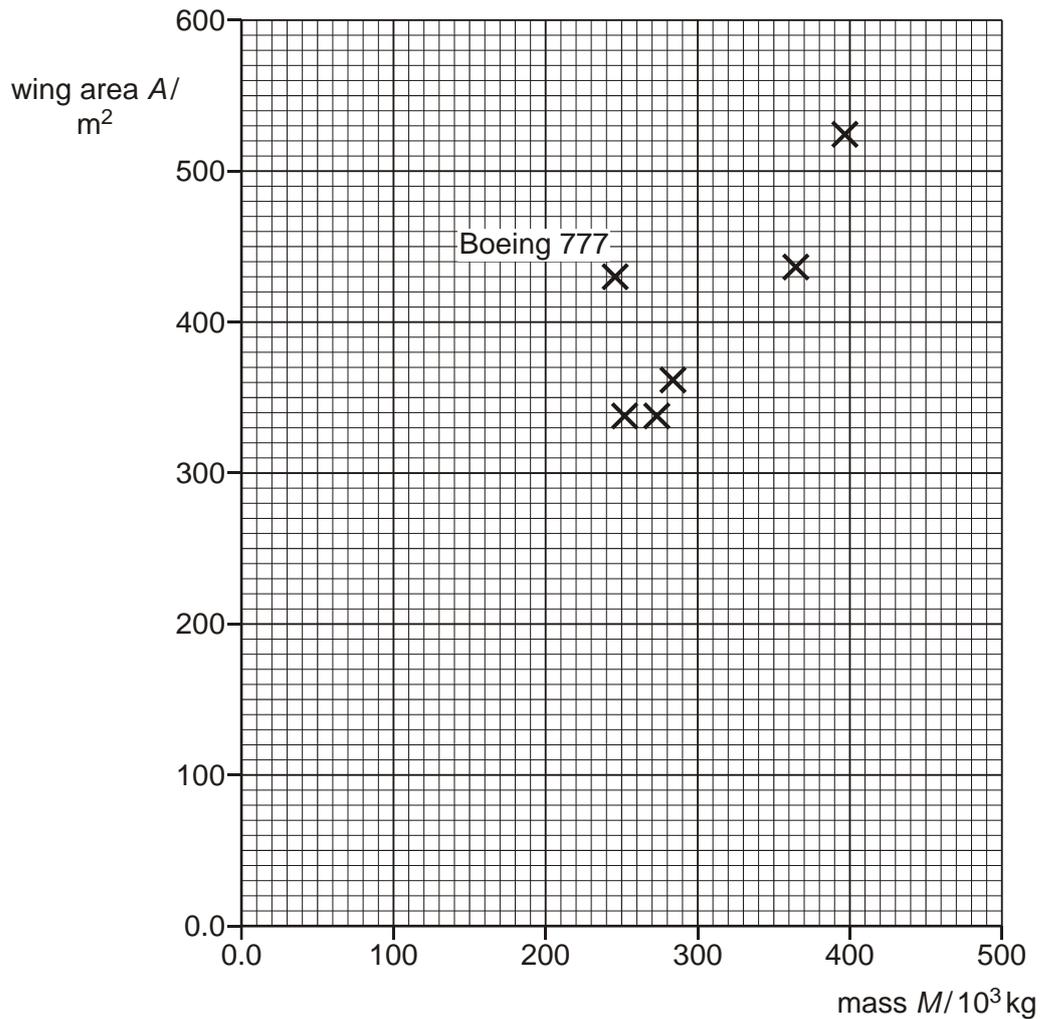
- (iii) The distance calculated in (b)(ii) is substantially less than the quoted take-off distance of 3100 m. Suggest and explain a reason for this.

[2]

- (c) In level flight, the lift required is directly proportional to the **mass** of the aircraft. Explain why.

[2]

- d) The graph below shows the relationship between maximum take-off mass  $M$  and wing area  $A$  for all six aircraft in the table.



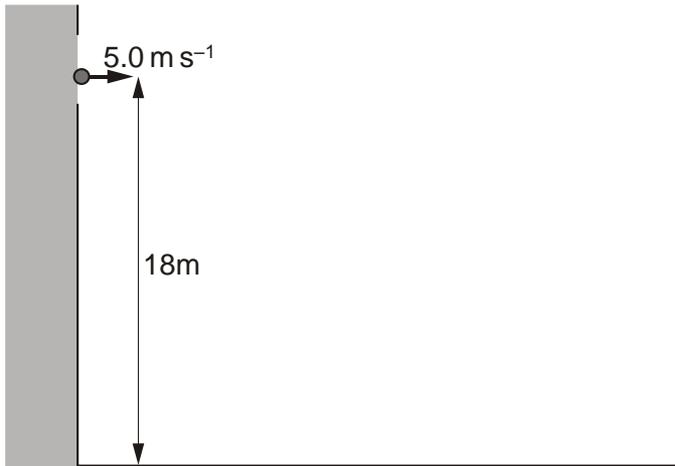
Draw a straight line of best fit on the graph above.  
What does the graph suggest about the design of these six aircraft?

[3]

[Total 16 marks]

2. A ball is thrown out of a window 18 m above the ground.

It is thrown horizontally at  $5.0 \text{ m s}^{-1}$ .



(a) Show that it takes about 2 seconds to reach the ground.

$$g = 9.8 \text{ m s}^{-2}$$

[2]

(b) Calculate the distance from the bottom of the building to the place where the ball hits the ground.

distance = ..... m

[1]

[Total 3 marks]

3. This question is about skydiving.

- (a) A skydiver falls from a stationary balloon high above the surface of the Earth. Air resistance can be neglected at this height since the density of the air is low.

Show that the time taken for the falling skydiver to accelerate to the speed of sound after leaving the balloon is more than 30 s.

speed of sound =  $330 \text{ m s}^{-1}$   
acceleration due to gravity =  $9.8 \text{ m s}^{-2}$

[3]

- (b) As the skydiver descends towards the Earth the density of the air increases

Fig. 1 shows how the velocity of the skydiver changes with time as he falls towards Earth, before opening his parachute.

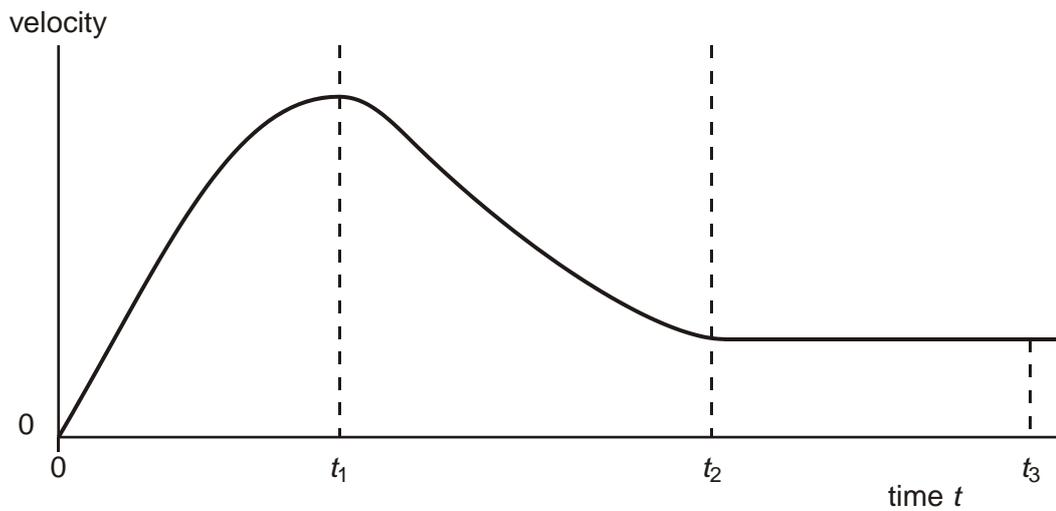


Fig. 1

- (i) Complete the following statements.

1 The area under a velocity-time graph represents

.....

2 The gradient of a velocity-time graph at any time represents

.....

[2]

- (ii) The graph shows three distinct stages of the skydiver's descent.

Using information from the graph, describe the motion of the skydiver in each of the time intervals shown on the graph.

$$t = 0 \text{ to } t = t_1$$

$$t = t_1 \text{ to } t = t_2$$

$$t = t_2 \text{ to } t = t_3$$

[3]

- (c) A camera man, in freefall alongside the skydiver, films every moment of the skydiver's descent.



camera man



skydiver

**Fig. 2**

At  $t = t_3$  the skydiver finally opens his parachute. The camera man continues in freefall. The film of the event shows the skydiver apparently accelerating upwards.

Explain this observation.

[2]

[Total 10 marks]

4. This question is about a projectile.

Fig. 1 shows a multi-flash picture of the motion of a dried pea fired horizontally from a pea shooter in a classroom.



Multi-flash picture of the motion of a dried pea fired horizontally from a pea shooter

**Fig. 1**

(a) The time interval between successive flashes is constant. At each flash, the new position of the pea is shown on the picture as a bright image on the dark background.

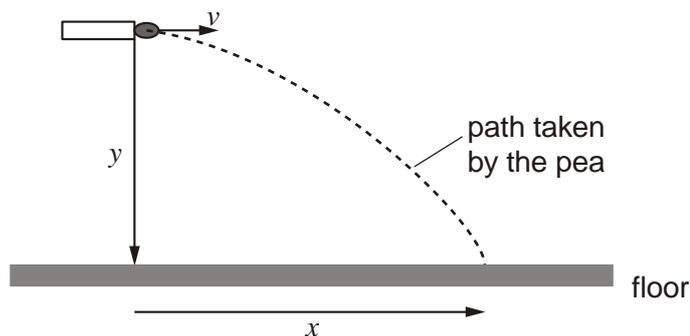
(i) Explain why the horizontal displacement of the pea increases by equal amounts between flashes.

[2]

(ii) Explain why the vertical displacement of the pea increases by increasing amounts between flashes.

[2]

(b)



**Fig. 2**

The pea is fired horizontally at speed  $v$  from a vertical distance  $y$  above the floor. It strikes the ground a time  $t$  later after travelling a horizontal distance  $x$  as shown in Fig. 2.

The horizontal range  $x$ , and the vertical distance fallen  $y$ , are given by the equations

$$x = vt \quad \text{equation 1} \quad \text{and} \quad y = \frac{1}{2}gt^2 \quad \text{equation 2}$$

where  $g$  is the acceleration due to gravity.

- (i) Rearrange **equation 1** and obtain an expression for  $t^2$  in terms of  $x$  and  $v$ .

$$t^2 = \dots\dots\dots [2]$$

- (ii) Rearrange **equation 2** and obtain an expression for  $t^2$  in terms of  $y$  and  $g$ .

$$t^2 = \dots\dots\dots [1]$$

- (iii) By combining the two expressions for  $t^2$  obtained in (i) and (ii) above, show that the horizontal speed  $v$  of the pea can be calculated from  $v^2 = \frac{gx^2}{2y}$ .

[1]

- (c) Calculate the speed  $v$  at which a dried pea leaves the pea shooter when it is fired horizontally from a height of 1.5 m above the ground to hit the bottom of a waste bin 4.0 m away.

$$g = 9.8 \text{ m s}^{-2}$$

[2]  
[Total 10 marks]