Newton's 2nd Law

Force = mass x acceleration
F = ma

Quantity	Symbol	Units
Force	F	Newtons (N)
Mass	m	Kilograms (kg)
Acceleration	a	Metres per second squared (m/s^2)

1. Rearrange the formula to:

a) make m the subject.
b) make a the subject.

[2 marks]

2) Calculate the missing quantity for the following. Show your working

a) Calculate the force required to accelerate a 5kg mass at $10m/s^2$.

b) A 3kg chicken propels itself with 15N of thrust from its wings. What acceleration does it achieve?

c) An explosive charge propels a bullet 1N of force with an acceleration of $1000m/s^2$. What is the mass of the bullet?

d) A fly has a mass of 15mg. What force does it wings provide to accelerate it at $20m/s^2$?

e) A 1500kg car needs to be jump started. What force does it need to be pushed with in order to accelerate at 0.75m/s2?

f) A aircraft with a mass of 80000kg is accelerated by producing 5.0×10^6N of thrust with its engines. Calculate the acceleration.

g) The recently invented plasma engine is designed to accelerate small spacecraft to the stars. The engine provides 8.0N of thrust on a spacecraft of mass 600g. Calculate the acceleration.

h) Gravity accelerates an object at $9.8m/s^2$ and a gives it a weight (force) of 680N. What is the objects mass?

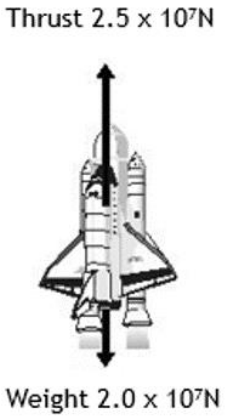
i) A crash test dummy of mass 80kg is involved in a car crash and decelerates at $50m/s^2$. What force does it experience?

j) Whilst skydiving, your physics teacher of mass 75kg experiences a force of 150N due to air resistance. What deceleration does this cause

[3 marks for each question]:

3. Apply your understanding of Newton's 2nd law to solve this problem:

a) At take off, the thrust force from the engines and the weight of a space shuttle are shown in the diagram.



i) State the size and direction of the resultant force on the space shuttle. [2]

ii) The space shuttle's mass on take off is 2.0 x 10^6kg. Calculate its acceleration at take off. [3]

iii) The shuttle's thrusters maintain a constant thrust force during flight, however, the acceleration increases. Explain why. [2]

SOLUTIONS

Newton's 2nd Law F=ma

Question	Answer	Marks / Notes
1a	m = F/a	1
1b	a = F/m	1
2a	F = ma = 5 x 10 = 50N	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units.
2b	a = F/m =15/3 =5m/s^2	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units.
2c	m = F/a =1/1000 =0.001kg or 1g	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units.
2d	F = ma = 15x10^{-3} x 20 = 0.3N	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units.
2e	F = ma = 1500 x 0.75 = 1125N or 1130N	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units. 2s.f. desirable
2f	a = F/m = 5.0 x 10^6 / 80000 = 63 m/s^2	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units. 2s.f. desirable

2g	a = F/m = 8.0 / 0.6 = 13 m/s^2	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units. 2s.f. desirable
2h	m = F/a = 680 / 9.8 = 69kg 2sf	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units.
2i	F = ma = 80 x 50 = 400N	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units.
2j	a = F/m = 150/75 = 2m/s^2	1 mark for correct substitution. 1 mark for correct answer. 1 mark for correct units.
3a		
i)	0.5 x 10^7 N Upwards	2
ii)	a = F/m = 0.5 x 10^7 / 2.0 x 10^6 = 2.5 m/s^2	3 marks Allow all marks for ecf in force
iii)	The mass / weight of the shuttle decreases as fuel is burnt. (1 mark) Therefore, the resultant force (thrust – weight) is greater. (1 mark)	2 marks