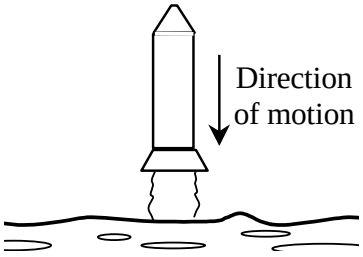
YEAR 12 PHYSICS. ASSIGNMENT #4. Due Monday 15th November.

Q1. (a) An approximate expression for the thrust force on a rocket when its motor is functioning is $F_{THRUST} = \frac{\Delta m}{\Delta t} v_{ex}$ By consideration of this expression, explain three ways to increase the thrust force acting on a rocket as it fires its booster in space, being careful to show you understand what is meant by each of the symbols used.

(b) The booster of a rocket with a total mass of 8000 kg is fired. Its exhaust gases are ejected at a speed of 3200 m s^{-1}, and fuel is consumed initially at a rate of 60 kg s^{-1}. What is the initial thrust force acting on the rocket?

(c) What is the consequent acceleration of the rocket?

(d) If the rocket motor continues to apply the same thrust, why does the rocket's acceleration gradually increase?

Q2. 

A 6000-kg rocket is coming in to land as shown on an airless asteroid having a gravitational acceleration of 2.5 m s^{-2}. Initially the rocket is moving downwards at 50 m s^{-1} from a height 100 m above the surface, and of course it must be effectively at zero velocity as it touches the surface.

(a) What is the weight of the rocket after it lands on the asteroid?

(b) Determine the resultant acceleration of the rocket, including its direction.

(c) Hence find the constant thrust force applied by the rocket motor during this time.

(d) What force would be experienced at this time by an 80-kg astronaut inside the vehicle?

(e) What would be the "g-load" undergone by the astronaut during this time?

Q3. (a) Explain why two-stage rockets are used in preference to single-stage rockets to launch satellites (or the Space Shuttle) into space.

(b) Why are four-stage (or more) rockets *not* used?

(c) Why is the period of rotation of the Earth <u>not</u> 86 400 seconds [i.e. exactly 24 hours]?

(d) Given that Earth takes 23 hours 56 minutes 4 seconds (86164 s) for one rotation, while its radius is 6378.137 km on the equator, determine the speed of a point on the equator due to Earth's rotation on its axis.

(e) In which direction does this point on Earth's equator travel?

(f) Because the elders will not give permission for the use of Cape York Peninsula for an Australian Space Base, the Mayor of Temma in north-western Tasmania (latitude 41° S) have offered to site such a base there, hoping to alleviate the unemployment problem. At the same time, the Government is considering a site on the Coburg Peninsula, north-east of Darwin (latitude 11° S) for the same reason. Determine the linear speed of the surface at each of these proposed sites, and use your results to explain which site would be preferable to the alternative, and why.