Edexcel, OCR

A Level

A Level Physics

MECHANICS: Fluids

Name:

Total Marks: /30

1. This question tackles the drag force experienced when an object falls freely through a fluid.

Total for Question 1: 10

(a) What is the cause of drag in fluids? [1]

(b) State three factors affect the magnitude of the drag force. [3]

(c) Draw a free-body diagram for a sinking object at each of the following points during its descent: [3]

i. The instant it is released.

ii. As it is accelerating.

iii. When it is travelling at its terminal velocity.

Be sure to label any forces indicated.

(d) For each of the cases in Part c, express the net acceleration in terms of *m, g and D* - the object's mass, the acceleration due to gravity and the drag force, respectively. [3]

2. Stokes' Law describes viscous drag acting on an object travelling at low speeds. From it, the following expression can be derived for a small sphere dropping through a viscous fluid:

$$v_{terminal} = \frac{2r^2 g(\rho_s - \rho_f)}{9\eta}$$

where r, ρ_s, ρ_f and η represent the sphere's radius, the densities of the sphere and the fluid and the fluid's viscosity, respectively. Sketch graphs showing the form of the following for positive values of all quantities:

Total for Question 2: 9

(a) $v_{terminal}$ vs η [2]

(b) $v_{terminal}$ vs r [2]

(c) $v_{terminal}$ vs $(\rho_s - \rho_f)$ [2]

(d) Briefly outline a simple experiment that could be used to determine a fluid's viscosity. Assume that any spheres' radii and the fluid's density are known. [3]

3. Here, you will explore the factors that affect buoyancy in fluids.

Total for Question 3: 11

(a) Explain why fluids exert a pressure. [1]

(b) Show that this pressure is $h\rho g$ for a vertical cylinder of length h and cross-sectional area A. [3]

(c) State Archimedes' Principle. [1]

(d) By considering a cuboid of thickness x buried with its top surface at a depth h, show that the upthrust will be $Ax\rho g$, where A is the area of its upper surface. [3]

(e) Icebergs typically float with 90% of their volume beneath the water. Given that $\rho_{water} = 1000\,\text{kgm}^{-3}$, use Archimedes Principle to calculate the density of the ice. [3]