For Examiner's Use

Section B

Answer **two** questions in this section.

5 **(a)** A car engine has a maximum rate of rotation of 5000 revolutions per minute. Express this angular velocity in radians per second.

angular velocity = ... rad s^{-1} [2]

(b) The Earth spins on its axis with a period of one day.

(i) Show that the angular velocity of a point on the Earth's surface is 7.27×10^{-5} rad s^{-1}.

[1]

(ii) Calculate the centripetal acceleration of a point on the Earth's equator. The radius of the Earth's equator is 6.38×10^{6} m.

centripetal acceleration = ... m s^{-2} [2]

(c) The acceleration of free fall g at the equator is not equal to the acceleration of free fall at the poles. Explain

(i) why they are different,

.....

.....

..... [2]

(ii) why the difference is small.

.....

.....

..... [1]

(d) (i) State Newton's law of gravitation.

.....

..... [1]

(ii) The mass M of the Earth may be considered to be concentrated at its centre. The radius of the Earth is R. Derive, in terms of M and R, the equation relating the Earth's gravitational field strength g to the gravitational constant G.

[2]

(e) (i) Calculate how far a satellite needs to be from the centre of the Earth for its angular velocity to be equal to the angular velocity of the Earth.

distance = ... m [3]

(ii) State two circumstances under which a satellite at this distance will be a geostationary satellite.

1. .....

.....

2. .....

..... [2]

(f) Many systems, such as the Global Positioning System, use several satellites in low orbits that pass over the Earth's poles. Suggest two advantages of these low polar orbits and two advantages of geostationary orbits.

polar orbit: advantage 1 .....

.....

polar orbit: advantage 2 .....

.....

geostationary orbit: advantage 1 .....

.....

geostationary orbit: advantage 2 .....

..... [4]