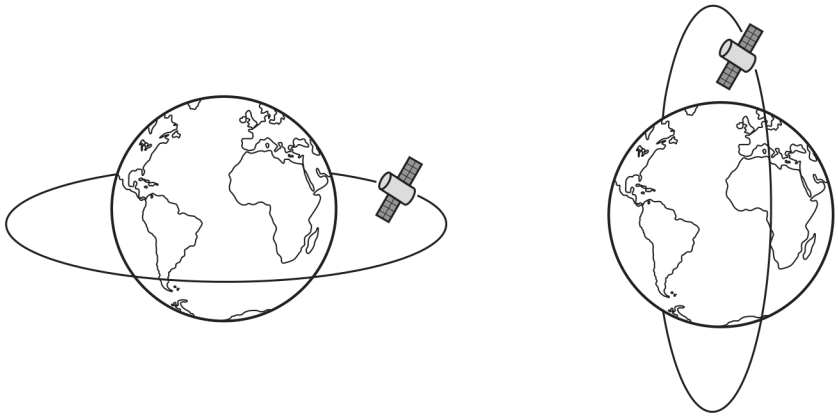
**21** Weather satellites may be in an equatorial orbit or a polar orbit, as shown.



equatorial orbit polar orbit

(a) A weather satellite in a polar orbit circles the Earth at a height of $8.50 \times 10^5$ m above the surface of the Earth.

(i) Show that the gravitational potential at this height is about $-5.5 \times 10^7\,J\,kg^{-1}$.

mass of Earth = $5.98 \times 10^{24}$ kg
radius of Earth = 6360 km

**(2)**

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(ii) Hence calculate the increase in gravitational potential energy when the satellite is placed in orbit.

satellite mass = 4990 kg
gravitational potential at the Earth's surface = $-6.27 \times 10^7\,J\,kg^{-1}$

**(2)**

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Increase in gravitational potential energy = .....

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(b) It is claimed that a satellite in orbit at a height of $8.50 \times 10^5$ m would make 15 orbits of the Earth every 24 hours.

Assess the validity of this claim.

**(5)**

(c) It is suggested that the satellite could be placed in an equatorial orbit at a radius of 42 200 km. With this radius the satellite would have an orbital period equal to 24 hours.

Give one advantage and one disadvantage of placing a weather satellite in a polar orbit rather than in the suggested equatorial orbit.

**(2)**

**(Total for Question 21 = 11 marks)**