2 **(a)** Define *gravitational potential* at a point.

.....

..... [1]

(b) The Earth, of radius 6400 km, has mass 6.0×10^{24} kg.

A global positioning satellite of mass 1600 kg is in an orbit of radius 2.7×10^{7} m about the centre of the Earth. The satellite is launched from the Earth's surface.

Calculate the change in gravitational potential energy ΔE_P for this satellite.

ΔE_P = ... J [2]

(c) **(i)** A satellite of mass m orbits a planet of mass M. The mass of the planet may be assumed to be a point mass at its centre.

Show that the kinetic energy E_k of the satellite in an orbit of radius r is given by

$$E_k = \frac{GMm}{2r}.$$

[2]

(ii) Use the information in **(b)** and the expression in **(c)(i)** to calculate the kinetic energy E_K of the global positioning satellite in its orbit.

E_K = ... J [1]

(iii) A student wants to calculate the change in kinetic energy of a satellite launched from the Earth to its orbit. The student calculates the initial and final kinetic energies using the expression in **(c)(i)**.

Suggest and explain whether the student's method is correct.

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..... [2]

[Total: 8]