E1

The disk rotates at 3000 revolutions per minute, i.e. 50 rev s^{-1}. Therefore the period T of revolution is

$$(1/50)\,\mathrm{s} = 0.02\,\mathrm{s}$$

The angular speed is related to the period by $\omega = 2\pi/T$

Therefore $\omega = (2\pi/0.02)\,\mathrm{rad\,s^{-1}} = 100\pi\,\mathrm{rad\,s^{-1}}$

The speed is given by $v = r\omega$. Hence (converting r to metres)

$$v = 0.05 \times 100\pi\,\mathrm{m\,s^{-1}} = 5\pi\,\mathrm{m\,s^{-1}} = 16\,\mathrm{m\,s^{-1}}$$

(Reread Subsection 3.2 if you had difficulty with this question.)

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E2

If we use the equation $\omega = v/r$ for the angular speed, we have

$$\omega = \frac{120}{5.00 \times 10^3}\ \text{rad s}^{-1} = 0.0240\ \text{rad s}^{-1}$$

The period is calculated from $T = 2\pi/\omega$

$$T = \frac{2\pi}{0.0240}\ \text{s} = 262\ \text{s}$$

The magnitude of the centripetal acceleration is given by

$$a = r\omega^2$$

so $a = 5.00 \times 10^3 \times 0.0240^2\ \text{m s}^{-2} = 2.88\ \text{m s}^{-2}$

(Reread Section 3 if you had difficulty with this question.)

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E3

(a) Statement (i) is incorrect and statement (ii) is correct. The word *uniform* refers to the speed. The theory described in this module is only applicable to situations where the motion follows a circular path and the speed is constant. (See Section 2.)

(b) Statement (i) is incorrect and statement (ii) is correct. Although gravity provides the radially directed inward force for an object on the Equator, this is not an adequate general definition. Statement (ii) is correct; it is applicable to all situations involving uniform circular motion. (See Subsection 3.4.)

(c) Statement (i) is incorrect and statement (ii) is correct. Period is defined as the time to complete one revolution. (See Subsection 3.2.)

(d) Statement (ii) is incorrect and statement (i) is correct. Angular speed is defined by the rate of change of angle

$$\omega = \frac{d\theta}{dt} \qquad \text{(Eqn 4b)}$$

which, for uniform circular motion, is the change in angle divided by the time interval. (See Subsection 3.1.)

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E4

Speed is defined by $v = ds/dt$ = limit of $(\Delta s/\Delta t)$ as Δt approaches zero, and $\Delta s = r\Delta\theta$. If we combine these two we have $v = rd\theta/dt = r\omega$.
(Reread Subsection 3.1 if you had difficulty with this question.)

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E5

From Equation 10c,

$$F = ma = mr\omega^2 \qquad \text{(Eqn 10c)}$$

the strength of the centripetal force can be written as

$$F = mr\omega^2$$

Substituting $2\pi/T$ for ω (from Equation 5)

$$T = \frac{2\pi}{\omega} \qquad \text{(Eqn 5)}$$

and rearranging gives $\quad m = \dfrac{FT^2}{4\pi^2 r}$

so $\quad m = \dfrac{5.19\times10^{22}\times(1.77\times24\times3600)^2}{4\pi^2\times4.22\times10^8}\ \text{kg} = 7.29\times10^{22}\ \text{kg}$

(Reread Subsection 4.2 if you had difficulty with this question.)

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E6

For a satellite to be in geostationary orbit over London, it would have to follow the path shown in Figure 10. But this is in disagreement with the condition for a satellite orbit explained in Subsection 4.2, that the centre of the Earth must also be the centre of the orbital plane. It follows that geostationary orbits are only possible if the satellite is stationed over the Equator.
(Reread Subsection 4.2 if you had difficulty with this question.)

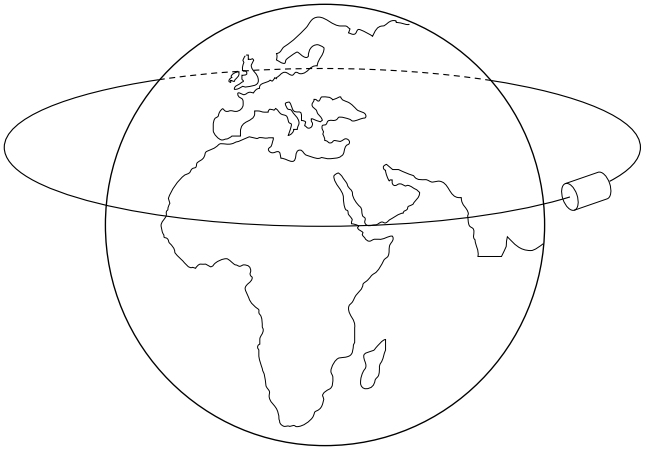

Figure 10 An impossible orbit; see Answer E6.

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