Physics Short Questions and Answers

Q1

When a hoop is released from the top of an inclined plane of height h, it reaches the bottom rolling without sliding with speed $V_{hoop} = \sqrt{(gh)}$. Show that the speed of a sphere will be $V_{sphere} = \sqrt{(10/7\ gh)}$.

Using the law of conservation of energy:
$mgh = (1/2)mv^2 + (1/2)I\omega^2$
For a sphere, $I = (2/5)mr^2$ and $\omega = v/r$. Substituting:
$mgh = (1/2)mv^2 + (1/2)((2/5)mr^2)(v^2/r^2)$
$mgh = (1/2)mv^2 + (1/5)mv^2$
$gh = (7/10)v^2$
$v = \sqrt{(10/7\ gh)}$
Thus, $V_{sphere} = \sqrt{(10/7\ gh)}$

Q2

Prove that critical velocity is 7.9 km/s.

The critical velocity is the orbital velocity:
$v = \sqrt{(GM/r)}$
Here, $G = 6.67\times10^{-11}$, $M = 5.97\times10^{24}$, and $r = R_E = 6.37\times10^{6}$. Substituting:
$v = \sqrt{((6.67\times10^{-11})(5.97\times10^{24})/(6.37\times10^{6}))}$
$v = 7.9$ km/s.
Thus, the critical velocity is 7.9 km/s.

QUESTION 3

Weight of a person is W in an elevator at rest. Show that weight will be 2W when the elevator is accelerating upward with acceleration g.

The apparent weight is given by:
$W' = mg + ma$
When $a = g$:
$W' = mg + mg = 2mg = 2W$.
Thus, the apparent weight is 2W.

QUESTION 4

A satellite is moving with a speed of 1.01 km/s along an orbital path of radius 390400 km. How many days will it take to complete one revolution?

The orbital circumference is:
$C = 2\pi r = 2\pi(390400) = 2452\times10^3$ km.
The time for one revolution is:

$T = C/v = (2452\times10^3)/(1.01\times10^3) \approx 2429$ seconds.
Convert this into days:
$T = 2429/86400 \approx 28$ days.
Thus, the satellite completes one revolution in 28 days.

QUESTION 5

Find the height of a geostationary satellite.

The orbital radius is given by:
$r = [(GMT^2)/(4\pi^2)]^{(1/3)}$
Substitute $G = 6.67\times10^{-11}$, $M = 5.97\times10^{24}$, and $T = 86400$:
$r = 42.2\times10^6$ m.
The height above Earth's surface is:
$h = r - R_E = 42.2\times10^6 - 6.37\times10^6 = 35.8\times10^6$ m.
Thus, the height of the satellite is $35.8\times10^6$ m.

QUESTION 6.

The distance is given by:
$d = \text{beam diameter}/\theta = 2.50/(6.6\times10^{-9})$
$d = 3.79\times10^8$ m.
Thus, the distance to the Moon is $3.79\times10^8$ m.

Q7

The Moon orbits the Earth so that the same side always faces the Earth. Determine the ratio of its orbital angular momentum to its spin angular momentum about its axis.

The orbital angular momentum is:
$L_{orbital} = mvr$
The spin angular momentum is:
$L_{spin} = I\omega = (2/5)mr^2(v/r) = (2/5)mvr$
The ratio is:
$L_{orbital}/L_{spin} = mvr/((2/5)mvr) = 5/2$.
Thus, the ratio is 5/2.