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Answers

Problem 'A'

1) Approximately, 3,500 to 5,000 stars are visible with the naked eye in the night sky.

2) The famous double star system Mizar and Alcor can be observed in the handle of the Big Dipper asterism.

3) Neowise C/2020 F3 is a comet
It is the first bright comet to be visible with the naked eye from the northen hemisphere since ~~1990s~~ the mid-1990s. Another special thing about it is that, it has a relatively long orbital period and was discovered on 27th March 2020.

4) Geminid meteor shower is taking place annually in December.

5) Cassiopeia

6) Cygnus

7) Andromeda

Problem 'B':

Let's consider the situation from the frame of reference of the wave. In this ~~situation~~ frame, the shock wave doesnot move and so, the spaceship approaches it with a speed of

$$v = -25000 \text{ km/s}$$
$$= -2.5 \times 10^7 \text{ m/s}$$

In order to be in safety, it should achieve a zero speed in this frame. This will happen in time:

$$t = \frac{0 - v}{a}$$

$$= \frac{-v}{a}$$

where, $a = 150 \text{ m/s}^2$ is the acceleration of the ship. In this time, the ship covers the following distance (towards the wave):

$$d = vt + \frac{at^2}{2}$$

$$= -\frac{v^2}{a} + \frac{v^2}{2a}$$

$$= \frac{-v^2}{2a}$$

$$= -\frac{(2.5 \times 10^7)^2}{2 \times 150}$$

$$\approx 2.1 \times 10^{12}$$

Since 15 AU is approximately 2.2×10^{12} m the crew manage to escape from the shock wave.

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Problem 'c'

a) Determine the total mass M of planet:

$$F = ma_c = G\frac{Mm}{R^2}$$

$$\Rightarrow a_c = \frac{GM}{R^2} \quad \text{---- (i)}$$

we know,

$$a_c = \frac{V^2}{R}$$

$$\Rightarrow a_c = \left(\frac{2\pi R}{T}\right)^2 \times \frac{1}{R}$$

$$\therefore a_c = \frac{4\pi^2 R}{T^2} \quad \text{------ (ii)}$$

from (i) & (ii),

$$\frac{4\pi^2 R}{T^2} = \frac{GM}{R^2}$$

$$\Rightarrow M = \frac{4\pi^2 R^3}{GT^2}$$

$$= \frac{4\pi^2 (4.8\times10^6)^3}{(6.67\times10^{-11})(7\times60\times60)^2}$$

$$= 1.03 \times 10^{26} \text{ kg.}$$

b) The planet is Neptune and the moon is Naiad with the semi-major axis of 48 224.41 km.

Problem: D

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(a) the gravitational potential energy at the distance r is:

$$E = -\frac{GMm}{r}$$

$$= -\frac{G\,\frac{4}{3}\pi R^3 m \rho}{r}$$

If $r = R+h$,

$$E = -\frac{G(4/3)\pi R^3 m \rho}{R+h}$$

(b) At the surface of the Moon the potential energy is given by,

$$E = -\frac{G(4/3)\pi R^3 m \rho}{R+0}$$

$$= -\frac{4}{3} G\pi R^2 m \rho$$

The total energy is:

$$K.E. + E = \frac{1}{2}mv^2 - \frac{4}{3}G\pi R^2 m\rho$$

At height h the kinetic energy is 0, so the total energy is $-\frac{4}{3}\frac{G\pi R^3 m\rho}{(R+h)}$

Then,

By the law of conservation of energy,

$$\frac{mv^2}{2} - \frac{4}{3}G\pi R^2 m\rho = -\frac{4}{3}\frac{G\pi R^3 m\rho}{(R+h)}$$

$\Rightarrow \frac{mv^2}{2} = \frac{4}{3} G\pi m\rho \left(\frac{R^3 + R^2 h - R^3}{(R+h)} \right)$

$\Rightarrow v^2 = \frac{8}{3} G\pi \rho \left(\frac{R^2 h}{R+h} \right)$

$\Rightarrow v^2 = \frac{8}{3} G\pi \rho R^2 \left(\frac{h}{R+h} \right)$

$\Rightarrow v^2 = \frac{8}{3} \pi G \rho R^2 \left(1 - \frac{R}{R+h} \right)$

$\therefore G = \frac{3}{8} \frac{v^2}{\pi \rho R^2} \left(1 - \frac{R}{R+h} \right)^{-1}$

c) lets substitute all the known parameters,

$G = \frac{3}{8} \frac{v^2}{\pi \rho R^2} \left(1 - \frac{R}{R+h} \right)^{-1}$

$= \frac{3}{8} \frac{(3013.6)^2}{\pi \times 3340 \times (1.74 \times 10^6)^2} \left(1 - \frac{1.74 \times 10^6}{(1.74 \times 10^6) + 21.5} \right)^{-1}$

$= 6.64 \times 10^{-11} \ N m^2 kg^{-2}$ ans

Problem 'E'

When the stars of mass greater than Chandrasekhar limit burns out all their fule and get collapsed into their own gravity, the electron degeneracy forms a neutron star. However, the angular momentum remains the same. Neutron stars are smaller than what they were before thus, the angular speed rises significantly. When the magnetic axis is not aligned with the axis of rotation, its periodical oscillation results in the emission of radiation in the direction of star's axis of rotation. From the perspective of an observer on earth, this seems like a star is pulsating. They are thus called pulsars (pulsating stars).