INTERNATIONAL ASTRONOMY AND ASTROPHYSICS COMPETITION

2020-2021

PROBLEM A:

SOLUTION:

(1) 9905

(2) THEY CAN BE FOUND IN THE REGON OF URSA MAJOR .

(3) IT IS BASICALLY A LONG PERIOD COMET WITH AN ORBITAL PERIOD OF 6800 YEARS AND A SEMIMAJOR AXIS OF 270 AU.

(4) QUADRANTIDS METEOR SHOWER.

(5) CASSIOPEIA

(6) CYGNUS

(7) SAGGITARIUS

PROBLEM B:

SOLUTION:

(15 AU=15*1.4*10^{8} KM=2.1*10^{9} KM).

THE CREW WILL BE SAVED ONLY IF THE SHOCKWAVE AND THE SPACESHIP NEVER COLLIDE.

FOR THIS TO HAPPEN THERE SHOULD BE NO REAL VALUE OF TIME FOR THEIR COLLISION.
LET THE TIME OF THE COLLISION BE T SECONDS.

SO THE DISTANCE TRAVELLED BY THE WAVE IN T SECONDS IS 2S000*T.

AND THE DISTANCE TO THE SPACESHIP IS $2.1*10^9$ +

$0.5*150*T^2$.

EQUATING THEM WE GET.

$25000T=2.1*10^9+75*T^2$

SOLVING THIS WE GET TWO VALUES OF TIME

T1=500/3 + 5288.877

T2=500/3 – 5288.877 (NEGATIVE NOT POSSIBLE)
SO THE CREW WILL NOT BE ABLE TO ESCAPE AND THE SHOCKWAVE WILL HIT THE SHIP AFTER 5454 SECONDS (APPROX).

PROBLEM C:

SOLUTION:

THE FORCE OF GRAVITY WILL PROVIDE THE NECESSARY GRAVITATIONAL FORCE FOR THE MOON.

SO WE HAVE,

$MV^2/R=G*(M*m/R^2)$

SO HERE WE PUT $V=\Omega R$ (WHERE Ω IS THE ANGULAR VELOCITY)

SO BY REARRANGING THE TERMS WE GET,

$4\pi^2R^3=GMT^2$

BY SOLVING THIS EQUATION WE HAVE

$M=4\pi^2R^3/GT^2$

PUTTING

$G = 6.67 \cdot 10^{-11}$, T=7*3600 s , R=48000*1000 m

WE GET THE VALUE OF M=$1{,}031*10^{26}$ KG (APPROX.)

PROBLEM D:

SOLUTION:

(A)

WE KNOW THAT P(X)=-∫F.dx

SO IN THIS CASE FORCE ON THE STONE AT ANY DISTANCE X FROM SURFACE IS

$F=GMm/(R+X)^2$

AND POTENTIAL ENERGY du= −F.dx

HENCE THE NET POTENTIAL ENERGY OF THE ROCK AT HEIGHT H IS

$$U=-\int_{-(INFINITY)}^{H} GMm/(r+X)\text{^}2.dx$$

SO

$U=GMm/(R+X)$

PUTTING $M=\rho(4/3)\pi R^3$ WE HAVE

$U=-(4/3)\pi GM\rho \cdot R^3/(R+H).$

(B)

FORM THE ABOVE EXPRESSION WE HAVE,

$E=-(4/3)\pi GM\rho \cdot R^3/(R+H)$ AT HIEGHT H

REARRANGING THE TERMS WE HAVE

$G=(3/8\pi)(v^2/pR^2)(R+h)/h$

AT A DISTANCE OF H=R WE HAVE THE VALUE OF

$G=(3/8\pi)(V^2/PR^2)(R+H)/R$

$G=(3/8)(V^2/PR^2)(1-R/(R+H))^{-1}$

(C)

PUTTING V= 30 AND H =21.5 IN THE ABOVE EXPRESSION (IN 3) WE GET

$G=1.769*10^{-8}$

PROBLEM E:

SOLUTION:

PULSARS ARE RAPIDLY SPINNING NEUTRON STARS, EXTREMELY DENSE STARS COMPOSED ALMOST ENTIRELY OF NEUTRONS AND HAVING A DIAMETER OF ONLY 20 KM (12 MILES) OR LESS.

NEUTRON STARS ARE SMALLER THAN WHAT THEY WERE BEFORE, THUS, THE ANGULAR SPEED SIGNIFICANTLY INCREASES. WHEN THE MAGNETIC AXIS IS NOT ALIGNED WITH THE AXIS OF ROTATION, ITS PERIODICAL OSCILLATION RESULTS IN THE EMISSION OF RADIATION IN THE DIRECTION

STAR'S AXIS OF ROTATION. FROM EARTH THIS SEEMS LIKE THE STAR IS PULSATING. THIS EXPLAINS THE PULSATING BEHAVIOR OF THE STARS..