Score: ___/82

1. A 900 kg car travels at a constant speed in a horizontal circle of radius 61 m with a period of 15 s. What is the centripetal force on the car?

A. 0.0 N
B. 11 N
C. 8.8×10^3 N
(D.) 9.6×10^3 N

$F_c = m\frac{4\pi^2 r}{T^2} = \frac{(900)(4)(\pi^2)(61)}{15^2}$

2. Two objects are separated by 2.3 m. One of the objects is 8.0 kg. The force of gravitational attraction between them is 5.0×10^{-10} N. What is the mass of the second object?

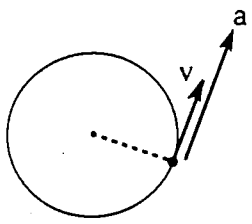
A. 0.20 kg
B. 0.50 kg
C. 2.2 kg
(D.) 5.0 kg

$F_g = \frac{GMm}{r^2} \Rightarrow m = \frac{F_g r^2}{GM}$

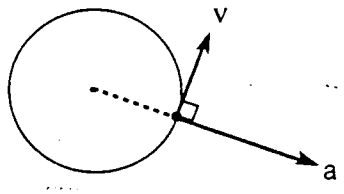
$m = \frac{(5\times10^{-10})(2.3^2)}{(6.67\times10^{-11})(8)} = 4.96$ kg

3. An object is in uniform circular motion. Which one of the following diagrams correctly shows the directions of the instantaneous velocity (v) and acceleration (a)?

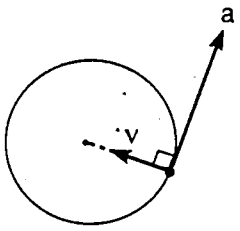
A.



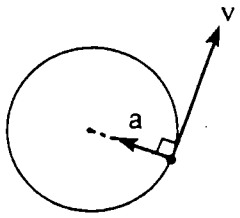
B.



C.



(D.)



4. A planet has a radius of 3.7×10^6 m. If the acceleration due to gravity at its surface is 5.4 m/s^2, what is the mass of this planet?

A. 7.5×10^{12} kg
B. 7.4×10^{13} kg
C. 3.0×10^{17} kg
(D.) 1.1×10^{24} kg

$a_g = \frac{GM}{r^2}$

$M = \frac{ar^2}{G} = \frac{(5.4)(3.7\times10^6)^2}{6.67\times10^{-11}}$

Name: Key
Block: ___

Physics 12 Test: Centripetal/Gravitation

/7

(5) 12. The work required to move an object in a planet's gravitational field can be determined graphically by calculating

1

A. the slope of a graph of gravitational force versus separation distance.
(B.) the area under a graph of gravitational force versus separation distance.
C. the slope of a graph of gravitational potential energy versus separation distance.
D. the area under a graph of gravitational potential energy versus separation distance.

(6) 13. The mass of Venus is 4.83×10^{24} kg. The gravitational force of the Sun on Venus is 5.47×10^{22} N. What is the distance between the Sun and Venus?

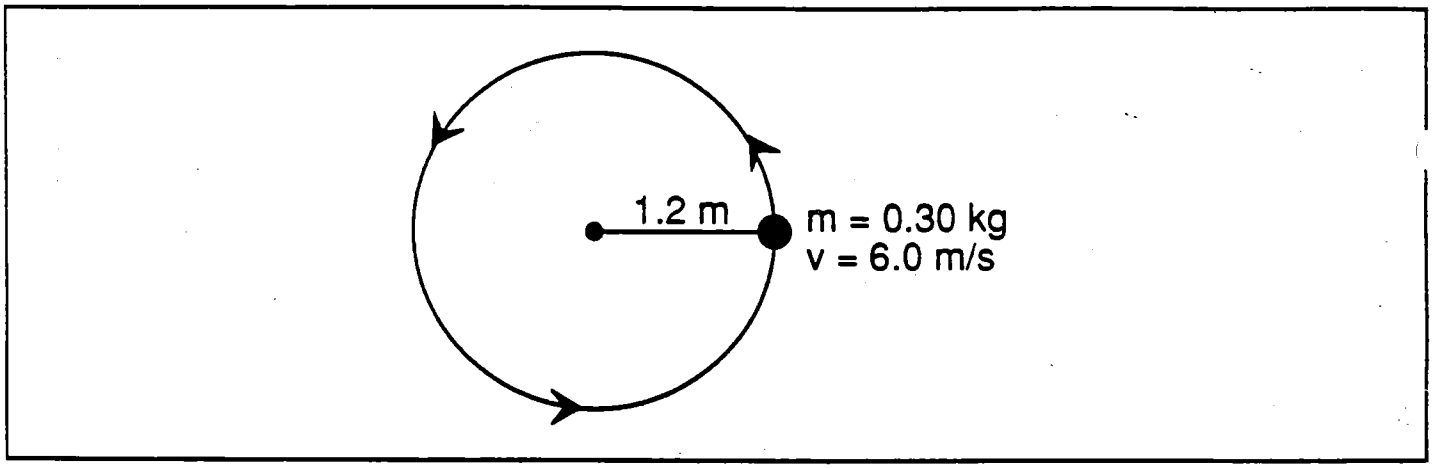
1/2

(A.) 1.08×10^{11} m
B. 1.20×10^{11} m
C. 1.17×10^{22} m
D. 1.44×10^{22} m

$F_g = \frac{GMm}{r^2} \Rightarrow r = \sqrt{\frac{GMm}{F}}$

$= \sqrt{\frac{(6.67\times10^{-11})(5.47\times10^{22})(1.98\times10^{30})}{4.83\times10^{24}}}$

Use the following diagram to answer question 12.



(7) 14. The above diagram shows a 0.30 kg air puck on the end of a string. The puck is moving in a horizontal circular path at a constant speed of 6.0 m/s. If the radius of the circular path is 1.2 m, what is the acceleration of the puck?

1/2

$a = \frac{v^2}{r} = \frac{6^2}{1.2} = 30$

A. Zero
B. $1.8\ m/s^2$
C. $9.0\ m/s^2$
(D.) $30\ m/s^2$

14. Two satellites orbit the Earth. The communications satellite has an orbital radius of 4.2×10^7 m and a period of 8.6×10^4 s. The weather satellite has an orbital radius of 6.8×10^6 m. What is the period of orbit for the weather satellite?

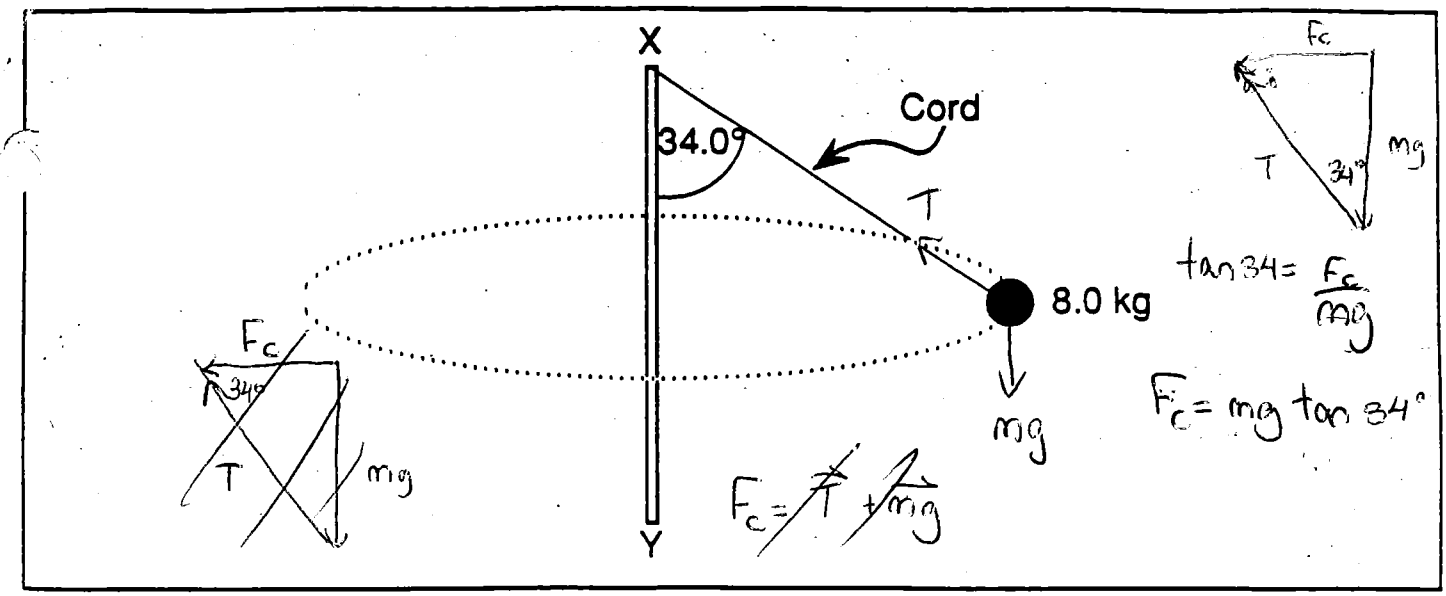
A. 5.6×10^3 s
B. 1.4×10^4 s
C. 2.6×10^4 s
D. 3.1×10^7 s

COMMENT

BAD

/5

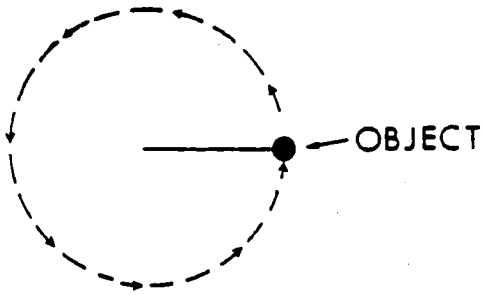
Use the following diagram to answer question 15.



15. (8) The above diagram shows an 8.0 kg object, attached to a cord, moving in a horizontal circular path around the vertical pole XY. The angle between the pole and the cord is 34.0°. What is the centripetal force acting on the 8.0 kg mass?

A. 6.6 N
B. 18 N
(C) 53 N
D. 140 N

Use the following diagram to answer question 11.



Use the diagram to the left to answer question 11 below.

11. (9) The above diagram shows an object on the end of a string being swung around in a circle. If the string breaks when the object is at the location shown, which vector below best represents the object's velocity immediately after the string breaks?

A. →

B. ↗

C. ↖

(D) ↑

10. A circular space station completes each rotation about its axis in 180 seconds. Due to the rotation of the space station, what will be the acceleration experienced by an astronaut standing on the rim of the space station, a distance of 2.0×10^3 m from its center?

A. $0.39\ m/s^2$
B. $1.2\ m/s^2$
C. $2.4\ m/s^2$
D. $9.8\ m/s^2$

$a_c = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2 (2\times10^3)}{180^2} =$

11. In an experiment conducted on the surface of a planet, a 2.6 kg steel ball drops to the ground with an acceleration of $7.3\ m/s^2$. If the radius of the planet is 4.8×10^6 m, what is the planet's mass?

A. 9.7×10^{23} kg
B. 2.5×10^{24} kg
C. 4.5×10^{24} kg
D. 6.0×10^{24} kg

$a_g = \frac{GM}{r^2}$ $\quad M = \frac{ar^2}{G} = \frac{(7.3)(4.8\times10^6)^2}{6.67\times10^{-11}}$

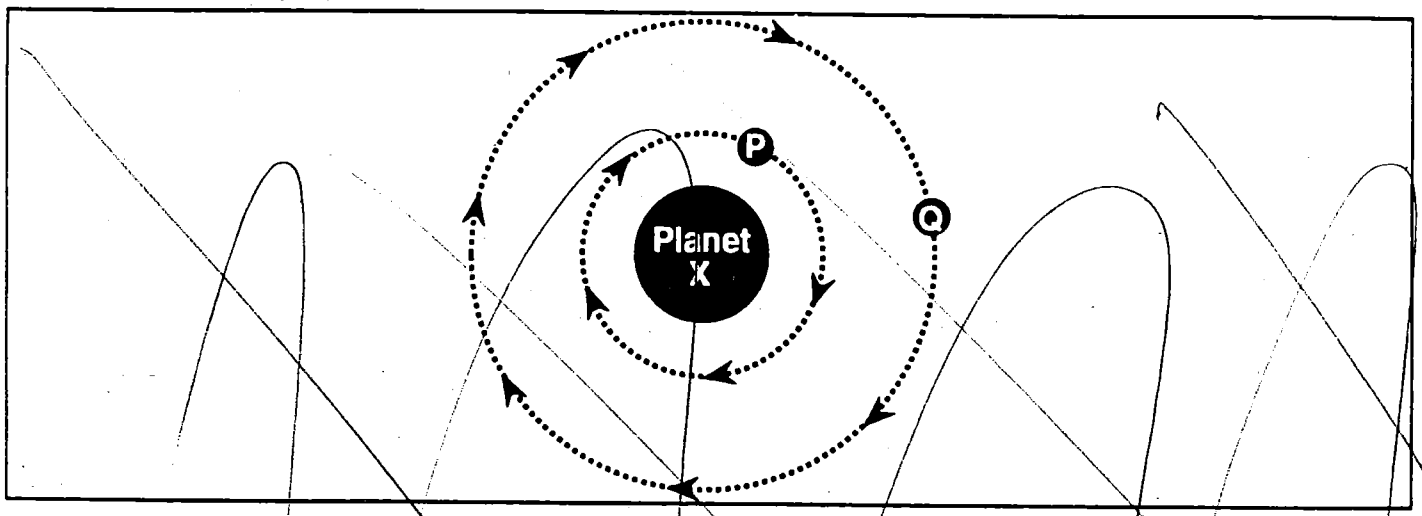
$M =$

12. A satellite of mass 2.5×10^4 kg orbits the Earth in a circle of radius 6.8×10^6 m. Relative to zero at infinity, what is the satellite's gravitational potential energy?

A. -1.5×10^{12} J
B. -5.9×10^{7} J
C. 2.2×10^{5} J
D. 1.0×10^{11} J

$E_p = -\frac{GMm}{r} = -\frac{(6.67\times10^{-11})(5.98\times10^{24})(2.5\times10^4)}{6.8\times10^6}$

Use the following diagram to answer question 14.



14. The diagram above shows two small satellites P and Q orbiting the same massive central planet X. The mass of Q equals four times the mass of P, and the radius of Q's orbit is twice that of P's orbit. If P takes 480 days to complete one revolution about X, how many days will Q take to complete one revolution about X?

A. 2.4×10^2 days
B. 6.8×10^2 days
C. 7.6×10^2 days
D. 1.4×10^3 days

CBA

/6

(13) qq. An object moves in a circle of radius 8.5 m with a period of 7.2 s. If the centripetal force needed for this motion is 36 N, what is the mass of the object?

(A.) 5.6 kg
B. 6.5×10^{-1} kg
C. 2.3×10^{2} kg
D. 2.0×10^{3} kg

$F_g = (m)\frac{(4\pi^2 r)}{T^2}$

$m = \frac{F \cdot T^2}{4\pi^2 r} = \frac{(36)(7.2^2)}{4\pi^2(8.5)} =$

(14) rr. A 1.8×10^{3} kg satellite orbits the Earth in a circle of radius 3.2×10^{7} m. What is the gravitational field strength at this radius?

A. 3.0×10^{-21} N/kg
(B.) 3.9×10^{-1} N/kg
C. 9.8 N/kg
D. 6.7×10^{2} N/kg

$g = \frac{GM_e}{r^2} = \frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})}{(3.2 \times 10^{7})^2}$

10. According to Kepler's laws of planetary motion, the Earth orbits the Sun in

A. a circular orbit, with the Sun at the centre.
B. an elliptical orbit, with the Sun at the centre.
C. an elliptical orbit, travelling at a constant speed.
D. an elliptical orbit, travelling with changing speed.

(15) ss. A 0.15 kg mass attached to the end of a string is whirled around in a vertical circle of radius 0.80 m. At the highest point in the circle the tension in the string is 0 N. What is the speed of the mass at this point?

(A.) 2.8 m/s
B. 4.0 m/s
C. 7.2 m/s
D. 16 m/s

$F_g = F_c \Rightarrow mg = \frac{mv^2}{r}$

$v^2 = rg$

$v = \sqrt{(.8)(9.8)} =$

(16) tt. What is the escape velocity for a 350 kg spacecraft from the surface of the Moon?

A. 1.6×10^{-7} m/s
B. 1.7×10^{3} m/s
(C.) 2.4×10^{3} m/s
D. 4.0×10^{5} m/s

$E_p = E_k$

$\frac{GMm}{r} = \frac{1}{2}mv^2$

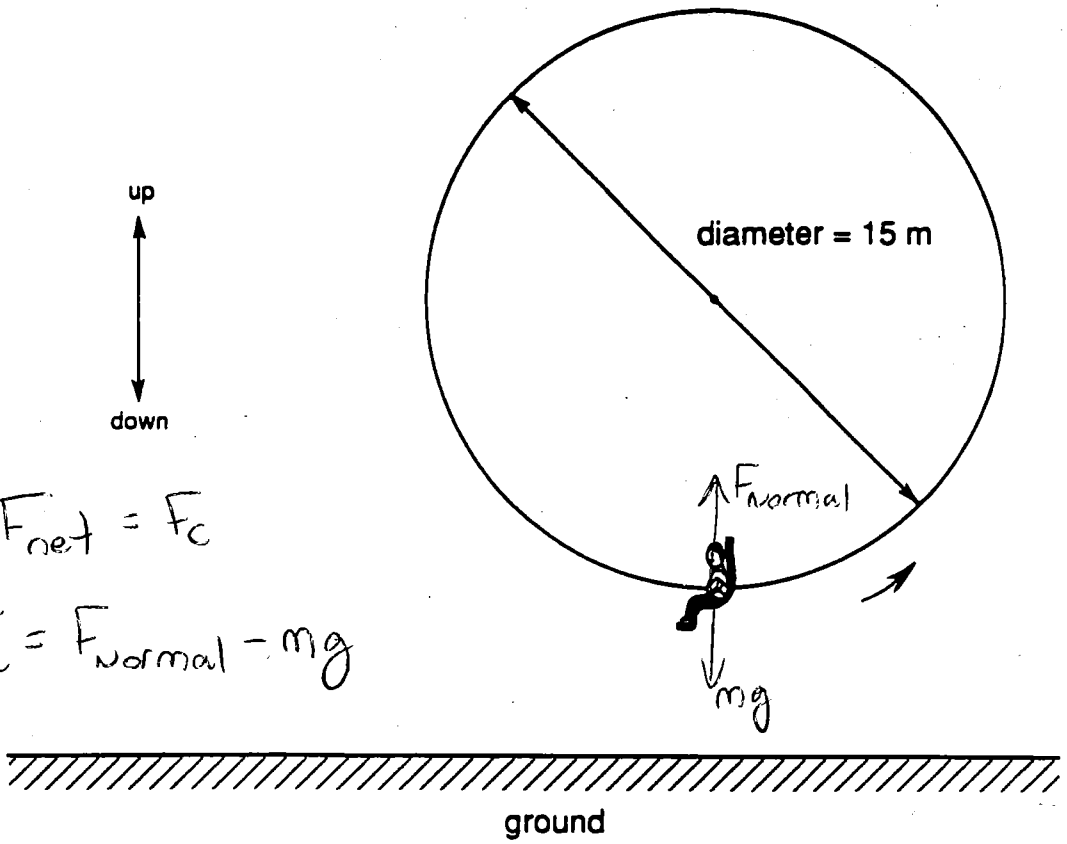
$v^2 = \frac{2GM}{r}$

$\Rightarrow v = \sqrt{\frac{2(6.67 \times 10^{-11})(7.35 \times 10^{22})}{(1.74 \times 10^{6})}}$

ABAC

/8

(17) 4. A 63 kg student is on a 15 m diameter ferris wheel rotating at a constant rate with a period of ~~X~~ 13 s.



$F_{net} = F_c$

$F_c = F_{normal} - mg$

What force does the seat exert on the student at the bottom of the circle, as shown in the diagram? **(7 marks)**

$$F_{normal} = F_c + mg = \frac{m4\pi^2 r}{T^2} + mg$$

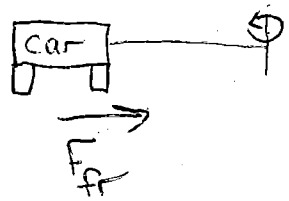
$$= \frac{(63)(4)(\pi^2)(7.5)}{13^2} + (63)(9.8)$$

$F_N = 727.7\ N$

$F_N = 7.3 \times 10^2\ N$

7

(18) *. A car travels at a constant speed in a circular path of 120 m radius. It completes one circuit in ~~21~~ 15 s. If the ground is level, what is the minimum coefficient of friction between the tires and the road? **(7 marks)**



$$F_{fr} = F_c$$

$$\mu F_N = m\frac{(4)(\pi^2)(r)}{T^2}$$

$$\mu mg = \frac{4\pi^2 r}{T^2}$$

$$\mu = \frac{4(\pi^2)(120)}{(15)^2(9.8)} = 2.15$$

(19) 4. The planet Saturn has a satellite Titan. The orbital radius of Titan is 1.22×10^9 m and its period of revolution is 7.37×10^6 s. What is the mass of Saturn? **(7 marks)**

7.37×10^6 s

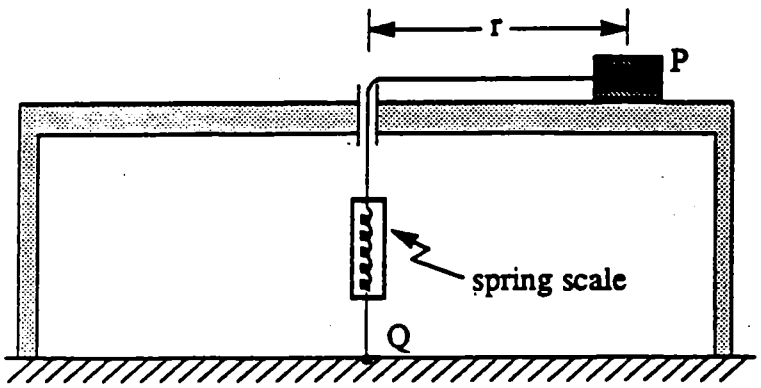
$$F_{grav} = F_{cent}$$

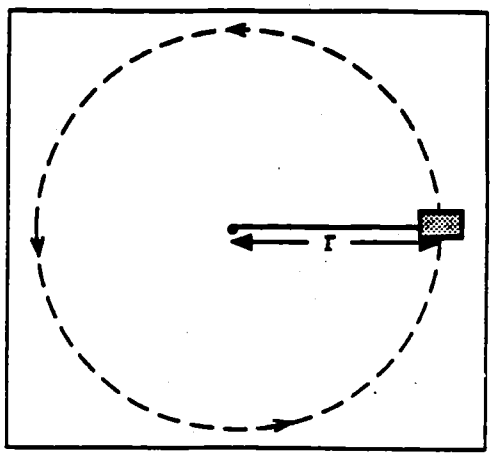
$$\frac{GMm}{r^2} = \frac{m(4)(\pi^2)(r)}{T^2}$$

$$M = \frac{4\pi^2 r^3}{T^2 G} = \frac{4(\pi^2)(1.22\times10^9)^3}{(7.37\times10^6)^2(6.67\times10^{-11})}$$

$$M_{Saturn} = 1.98\times10^{25}\ kg$$

20. A puck P is connected by a cord and a spring scale to point Q, through a frictionless tube set in the centre of a horizontal frictionless table, as shown below. When the puck is set into uniform circular motion with a period of 2.6 s and a radius of 0.16 m, the spring scale reads a tension of 0.24 N.





View from above

(a) What is the mass of the puck? **(4 marks)**

$$\text{Tension} = F_c$$

$$.24 = \frac{m(4)(\pi^2)(r)}{T^2}$$

$$m = \frac{(.24)(T^2)}{4\pi^2 r} = \frac{(.24)(2.6^2)}{4\pi^2(.16)} = 0.257 \text{ kg} \quad m = 2.57 \times 10^{-1} \text{ kg}$$

(b) When the period of rotation is shortened to 2.2s, the spring stretches to read 0.52N. What is the new radius of revolution? (3 marks)

$$T_{\text{tension}} = F_c$$

$$T_{\text{tension}} = \frac{m(4)(\pi^2)(r)}{T^2}$$

$$r = \frac{(.52)(2.2)^2}{(2.57 \times 10^{-1})(4)(\pi^2)} = 0.248 \text{ m}$$

$$r = 2.48 \times 10^{-1} \text{ m}$$

DO NOT WRITE IN THIS COLU

(21) 8. An object is fired vertically into space from the surface of the moon. With what initial speed must the object be fired for it to reach a maximum distance of 8.00×10^6 m from the centre of the moon?

8.00×10^6 m

/7

mention

$PE_i + KE_i = PE_f + KE_f$ ($KE_f = 0$) $F_g = F_c$ approach

$-\frac{GMm}{r_{moon}} + \frac{1}{2}mv^2 = -\frac{GMm}{r_{final}} + 0$ masses cancel!

$$-\frac{(6.67\times10^{-11})(7.35\times10^{22})}{8\times10^6} + \frac{(6.67\times10^{-11})(7.35\times10^{22})}{1.74\times10^6} = \frac{1}{2}v^2$$

$-612806 + 28175500 = \frac{1}{2}v^2$

$v^2 = 44093388$

$v = 2100$ m/s

$\boxed{v = 2.1\times10^3 \text{ m/s}}$

(22) 9. A 900 kg satellite which is travelling at 8 600 m/s around a planet of mass 8.1×10^{25} kg has an orbital radius of 7.3×10^7 m. What is the total orbital energy of this satellite relative to infinity? **(7 marks)**

$TE = PE + KE$

$= -\frac{GMm}{r} + \frac{1}{2}mv^2$

which mass is moving?

$= -\frac{(6.67\times10^{-11})(8.1\times10^{25})(900)}{7.3\times10^7} + \frac{1}{2}(900)(8600)^2$

$TE = -3.33\times10^{10}$ J

/14

(23) **Explain how it is possible to have a centripetal acceleration when an object is travelling at a constant speed in a circle.**

(4 marks)

during circular motion, velocity changes although speed does not. Since velocity changes (its direction!), there must be an acceleration.

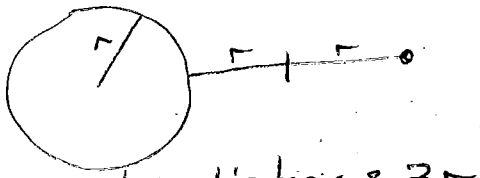
$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

(24) A satellite travels in a circular orbit at a height of ~~One~~ Two Earth radius above the surface of the Earth. What is the satellite's orbital period?

(7 marks)

$F_{cent} = F_{grav}$

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



Total distance: $3r$

$T^2 = \frac{4\pi^2 r^3}{GM}$

$T = \sqrt{\frac{4(\pi^2)(3 \times 6.38 \times 10^6)^3}{(6.67 \times 10^{-11})(5.98 \times 10^{24})}} = 26344$ sec.

$T = 2.63 \times 10^4$ sec

6 marks for: 1.4×10^5 sec.

11