Circular Motion and Universal Gravitation Answers

1. D (Aug ’99, 12)

2. 26 N (Aug ’99, 13)

3. 1.4×10^2 N (Aug ’99, 14)

4. $F_{top} = 6.9 \times 10^2$ N $F_{bottom} = 7.8 \times 10^2$ N (Aug ’99, 15)

5. D (Aug ’99, 16)

6. A 0.098 m/s^2 (Aug ’99, 17)

7. a) 5.5×10^3 b) less than (Aug, ’99, 17) c) The satellites speed in a stable orbit is inversely proportional to the square root of orbit radius. v = 1/sqroot(r). Therefore, in an orbit with twice the radius of the first, the satellite speed will be lower.

8. 69 N (Jan ’99, 13)

9. 5.6×10^3 N (Jan ’99, 14)

10. D (Jan, ’99, 15)

11. 1.7 N/kg (Jan ’99, 16)

12. -4.4×10^{10} J (Jan ’99, 17)

13. a) $2.4x10^{-2} m/s^2$ (Jan ’99, 4LA)

    b) $5.2x10^{26} kg$

14. II (June ’99, 13)

15. $13 m/s^2$ (June ’99, 14)

16. $5.9x10^{-3} m/s^2$ (June ’99, 15)

17. $4.2x10^7$m (June ’99, 18)

18. A (June ’99, 16)

19. D (June ’99, 17)

20. B (June ’99, 21)

21. $\frac{Gm_E m_S}{r^2} = \frac{m_S x v^2}{r} \rightarrow \therefore \mathrm{v} = \left(\frac{Gm_E}{r}\right)^{\frac{1}{2}} \rightarrow \left(\frac{6.67x10^{-11} N*m^2*kg^2*5.98x10^{24} kg}{4.2x10^7 m}\right)^{\frac{1}{2}} \rightarrow = 3.1x10^3 m/s$

$E_k = \frac{1}{2}mv^2 \rightarrow \frac{1}{2} * 1500kg(3.1x10^3 m/s^2)^2 \rightarrow 7.1x10^9 J$

22. $5.1x10^3$J (Jan ’00, 5)

23. $1.1x10^4$N [Left] (Jan '00, 7)

24. 9.4m/s, inelastic (Jan '00, 8)

25. 36kg*m/s (Jan '00, 9)

26. III (Jan '00, 13)

27. $8.22x10^{-2}$N (Jan '00, 14)

28. 3.6m/s (Jan '00, 14)

29. D (Jan '00, 16)

30. $6.95x10^6$m (Jan '00, 17)

31. $2.99x10^9$J (Jan '00, 18)

32. a) $3.8m/s^2$

b) $6.4x10^{23}$kg

33. 15.2N (June '00, 15)

34. D (June '00, 16)

35. B (June '00, 14)

36. $3.7x10^{-8}$N (June '00, 17)

37. $5.29X10^{25}$kg (Aug '00, 17)

38. 1.8kg (Aug '00, 13)

39. $4.7x10^3$N (Aug '00, 14)

40. a) $F_c = F_g \rightarrow \frac{mv^2}{R} = \frac{GMm}{R^2} \rightarrow v^2 = \frac{GM}{R} \rightarrow v = \sqrt{\frac{GM}{R}}$ $v = 7.73x10^3$m/s

b) Less than

c) As the space shuttle moves further away from the Earth's centre the force of gravity active on the shuttle decreases. Since the centripetal force is provided by the force of gravity, it must decrease as well. The smaller centripetal force generates a smaller centripetal acceleration which in turn requires a smaller orbital velocity.

41. The reading will be greater than 14N. $\left(by\ \frac{mv^2}{r}\right)$

Initially, the net force is zero, so the spring scale reads the weight of the mass. When moving, there is a net (centripetal) force provided by the spring scale (tension in the rope) which exceeds the weight (force of gravity) of the mass so that the mass goes in a vertical circle. (3 marks)

42. D (Aug '00, 15)

43. $1.2x10^3$kg (Aug '00, 16)

44. R_1 = $6.38x10^6$m → R_2 = $6.38x10^6$m + $3.2x10^5$m → = $6.70x10^6$m (1 mark)

W = ΔE → $\Delta E_P = E_{P2} - E_{P1}$

$= \frac{-GMm}{R_2} - \left(-\frac{GMm}{R_1}\right)$

$= \frac{-6.67x10^{-11}x5.98x10^{28}x4.00x10^3}{6.70x10^6}$ - $\frac{-6.67x10^{-11}x5.98x10^{24}x4.00x10^3}{6.38x10^6}$

= $-2.38x10^{11}$J – (- $2.50x10^{11}$J)

$1.2x10^{10}$J

45. D (Jan '01, 16)

46. D (Jan '01, 18)

47. $F_{Top} = 4.3x10^2$N, $F_{Bot} = 5.9x10^2$N (Jan '01, 17)

48. 24N (Jan '01, 19)

49. a) 3.61N/kg b) 421N (Jan '01, 17)

50. a) ≅ 7W b) ≅ 35W (Aug '00, 8LA)