Engineering Daily Exam 10 [Home Practice] EV

Work, Energy & Power + Gravitation & Gravity

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. Find the gravitational self-energy of a uniform solid sphere of mass $M = 8 \times 10^{24}$ kg and radius $R = 7.2 \times 10^{6}$ m.

   (A) -2.225×10^{32} J (B) -1.778×10^{32} J
   (C) -3.556×10^{32} J (D) $+2.225 \times 10^{32}$ J

2. What will be the weight of a 60 kg person in a spacecraft located at a height of 1500 km above the Earth's surface? (Earth radius R = 6400 km)

   (A) 512.4 N (B) 421.5 N
   (C) 385.8 N (D) 588 N

3. A 600 g rubber ball hits a wall perpendicularly at 18 ms^{-1} and rebounds at 10 ms^{-1}. How much kinetic energy was converted to heat and sound?

   (A) 67.2 J (B) 18.6 J (C) 30.0 J (D) 48.6 J

4. A 4 kg block is pushed 10 m across a frictionless table by a constant 30 N horizontal force, then the force is removed and the block enters a rough section ($\mu = 0.25$). Find the block's speed at the instant it enters the rough section.

   (A) 12.25 ms^{-1} (B) 6.12 ms^{-1}
   (C) 8.66 ms^{-1} (D) 10.95 ms^{-1}

5. Find the orbital period of a satellite orbiting at a height of 15 km above Earth's surface. (R = 6400 km, g = 9.8 ms^{-2})

   (A) 5078 s (B) 3.26×10^{10} s
   (C) 5092 s (D) 2.01 s

6. Point masses of 3 kg, 4 kg, and 5 kg are placed at the vertices of an equilateral triangle of side 0.6 m. Find the total gravitational potential energy of the system.

   (A) -8.342×10^{-9} J (B) -5.227×10^{-9} J
   (C) -4.171×10^{-9} J (D) $+5.227 \times 10^{-9}$ J

7. A solid rubber ball is dropped from 6 m and rebounds to 3.6 m. What percentage of kinetic energy is lost?

   (A) 60% (B) 64% (C) 40% (D) 20%

8. Water is lifted from a well 150 m deep at a rate of 120 kg per minute. If the engine's efficiency is 70%, find the engine's power in horsepower.

   (A) 5.62 HP (B) 8.94 HP
   (C) 4.20 HP (D) 3.15 HP

9. In a right-angled triangle ABC with the right angle at A, AB = 4 m and AC = 5 m. Point masses of 3 kg, 4 kg, and 6 kg are placed at A, B, and C respectively. Find the magnitude of the net gravitational force on the mass at A.

   (A) 6.94×10^{-11} N (B) 9.21×10^{-11} N
   (C) 5.12×10^{-11} N (D) 3.02×10^{-11} N

10. A 1800 kg vehicle starts from rest and reaches a height of 600 m with a speed of 90 ms^{-1}. If the engine's efficiency is 55%, find the input energy consumed by the engine.

    (A) 13.86 MJ (B) 32.50 MJ
    (C) 8.42 MJ (D) 38.72 MJ

11. If the gravitational constant G were suddenly doubled, how would Earth's orbital period change?

    (A) $\frac{T}{\sqrt{2}}$ (B) 0.5T (C) T (D) 2T

12. A child on a swing (rope length 3.5 m) is pulled back so the seat rises 0.9 m above its lowest point. Air resistance dissipates 12% of the energy. Find the child's speed at the lowest point.

    (A) 3.940 ms^{-1} (B) 4.162 ms^{-1}
    (C) 3.548 ms^{-1} (D) 4.500 ms^{-1}

13. A thin, uniform spherical shell of mass $M_1 = 6 \times 10^{24}$ kg and radius $R_1 = 9 \times 10^{6}$ m has a smaller shell ($M_2 = 3 \times 10^{24}$ kg, $R_2 = 4 \times 10^{6}$ m) inside it, concentric with it. Find the potential at $r = 6 \times 10^{6}$ m from the center.

    (A) -4.45×10^{7} Jkg^{-1}
    (B) -3.34×10^{7} Jkg^{-1}
    (C) -7.79×10^{7} Jkg^{-1}
    (D) -1.112×10^{8} Jkg^{-1}

14. A vertical spring ($k = 2500\ Nm^{-1}$) is compressed 25 cm by a 0.5 kg ball. How high will the ball rise?

Ⓐ 12.75 m Ⓑ 15.94 m

Ⓒ 63.78 m Ⓓ 31.89 m

15. Planet A orbits planet B once every 80 days at radius 4×10^5 km. If planet C orbits once every 150 days, find its orbital radius.

Ⓐ 6.08×10^5 km Ⓑ 12.96×10^5 km

Ⓒ 2.08×10^5 km Ⓓ 5.02×10^5 km

16. A 2 kg block is released from 10 m height on a frictionless track. What is its speed at 4 m height?

Ⓐ $15.33\ ms^{-1}$ Ⓑ $10.84\ ms^{-1}$

Ⓒ $7.67\ ms^{-1}$ Ⓓ $5.42\ ms^{-1}$

17. On a frictionless table, 3 kg and 5 kg blocks are connected. When the 5 kg block falls 1.8 m, what is the speed of the system?

Ⓐ $5.94\ ms^{-1}$ Ⓑ $4.70\ ms^{-1}$

Ⓒ $4.20\ ms^{-1}$ Ⓓ $2.42\ ms^{-1}$

18. A planet's density is $\varrho(r) = \varrho_0\left(1 - \frac{2r}{3R}\right)$. At what distance is g maximum?

Ⓐ $r = \frac{R}{2}$ Ⓑ $r = \frac{R}{3}$

Ⓒ $r = \frac{2R}{3}$ Ⓓ $r = R$

19. Same kinetic energy is given to objects on planets X and Y. X's g is 4 times Y's. Find $h_x : h_y$.

Ⓐ 1 : 2 Ⓑ 1 : 4 Ⓒ 1 : 1 Ⓓ 4 : 1

20. Two identical stars (3×10^{30} kg each) are separated by 5×10^{11} m. Find the orbital speed.

Ⓐ $8.94\ kms^{-1}$ Ⓑ $17.88\ kms^{-1}$

Ⓒ $14.15\ kms^{-1}$ Ⓓ $25.28\ kms^{-1}$

21. At the top of a loop of radius R, the normal force is 1.5 times the weight. Find the relation between h and R.

Ⓐ $h = 4.5R$ Ⓑ $h = 2.5R$

Ⓒ $h = 3.25R$ Ⓓ $h = 3R$

22. A planet has mass 8×10^{25} kg, radius 7500 km, period 20 hours. How much does the weight of a 15 kg object at 40° from the axis decrease?

Ⓐ 0.121 N Ⓑ 0.485 N

Ⓒ 0.243 N Ⓓ 0.354 N

23. At what height above Earth's surface will g = $4.0\ ms^{-2}$? ($M = 5.97 \times 10^{24}$ kg, $R = 6.4 \times 10^6$ m)

Ⓐ 2.78×10^6 m Ⓑ 3.60×10^6 m

Ⓒ 4.21×10^6 m Ⓓ 6.40×10^6 m

24. A 1.5 kg block is released from 10 m height. How far up a 53° incline will it go?

Ⓐ 12.53 m Ⓑ 6.26 m Ⓒ 10.00 m Ⓓ 16.62 m

25. A rocket is launched at $9\ kms^{-1}$ from a planet's surface. How high will it go? (R = 6400 km, g = $9.8\ ms^{-2}$)

Ⓐ 16500 km Ⓑ 11664 km

Ⓒ 8400 km Ⓓ 4100 km

26. A rectangular tank (4 m × 5 m × 6 m) is to be emptied in 20 minutes. Find the HP of a 60% efficient motor.

Ⓐ 8.75 HP Ⓑ 2.41 HP Ⓒ 6.57 HP Ⓓ 4.37 HP

27. An escalator moves at $0.85\ ms^{-1}$ at 35°. What power is needed to lift a 75 kg person up 7 m?

Ⓐ 437.5 W Ⓑ 625.0 W Ⓒ 358.4 W Ⓓ 312.5 W

28. A uniform sphere has mass 3×10^4 kg and radius 3.0 m. Find the field intensity at 0.8 m from the center.

Ⓐ $4.76 \times 10^{-8}\ Nkg^{-1}$ Ⓑ $3.09 \times 10^{-6}\ Nkg^{-1}$

Ⓒ $5.93 \times 10^{-8}\ Nkg^{-1}$ Ⓓ $6.79 \times 10^{-8}\ Nkg^{-1}$

29. Mass of planet A is 49 times B, distance is 50×10^9 km. At what distance from A will the gravitational pull be equal?

Ⓐ 25.00×10^9 km Ⓑ 43.75×10^9 km

Ⓒ 6.25×10^9 km Ⓓ 46.88×10^9 km

30. A 0.5 kg projectile is fired horizontally at $10\ ms^{-1}$. What is its kinetic energy at the highest point? (h_{max} = 5 m)

Ⓐ 25 J Ⓑ 0 J Ⓒ 12.5 J Ⓓ 37.5 J

31. The Earth-Moon distance is 3.84×10^5 km. Where is the field zero, measured from Earth? ($M_E = 5.97 \times 10^{24}$ kg, $M_M = 7.35 \times 10^{22}$ kg)

Ⓐ 3456 km Ⓑ 34560 km

Ⓒ 192000 km Ⓓ 345600 km

32. The Sun's mass is 1.989×10^{30} kg, radius 6.96×10^8 m. Find the escape velocity.

(A) $617.6\ \text{kms}^{-1}$ (B) $436.7\ \text{kms}^{-1}$

(C) $19531\ \text{kms}^{-1}$ (D) $0.0234\ \text{kms}^{-1}$

33. A pump lifts 18000 litres per hour to 40 m height. At 65% efficiency, what is the power in kW?

(A) 1.846 kW (B) 8820 kW

(C) 3.017 kW (D) 1.2 kW

34. An 800 kg car brakes from $12\ \text{ms}^{-1}$ to stop. If $\mu = 0.5$, find the stopping distance.

(A) 14.69 m (B) 2.45 m (C) 7.35 m (D) 4.41 m

35. A hollow sphere has mass 10 kg, radius 0.5 m. Find the ratio of field at 0.2 m and 0.8 m.

(A) 16 : 1 (B) 1.024 : 1

(C) 0 (D) Infinite

36. Mass increases by 60%, radius decreases by 15%. Find the percentage change in escape velocity.

(A) Increases by 137.2% (B) Increases by 88.2%

(C) Decreases by 12.5% (D) Increases by 37.2%

37. A 0.4 kg block hits a spring ($k = 1000\ \text{Nm}^{-1}$) at $5\ \text{ms}^{-1}$. Find the maximum compression.

(A) 0.1414 m (B) 0.1000 m

(C) 0.0707 m (D) 0.0354 m

38. At what height above Earth's surface should a satellite be placed so it is visible 4 times a day?

(A) 1.68×10^4 km (B) 1.39×10^4 km

(C) 0.84×10^4 km (D) 2.02×10^4 km

39. Which graph correctly shows E vs r for a uniform solid sphere?

(A) Inside linear, outside inverse-square

(B) Inside constant, outside inverse-square

(C) Inside inverse-square, outside linear

(D) Constant everywhere

40. A 30 kg crate is pushed up a 20° ramp of length 8 m ($\mu = 0.35$), reaching $3\ \text{ms}^{-1}$ at the top. Find the work done by the worker.

(A) 1043.6 J (B) 524.7 J

(C) 579.9 J (D) 1713.0 J

41. A 300 kg block is lifted by an 8 HP crane at 60% efficiency. What is the speed?

(A) $1.22\ \text{ms}^{-1}$ (B) $2.03\ \text{ms}^{-1}$

(C) $0.0016\ \text{ms}^{-1}$ (D) $3.05\ \text{ms}^{-1}$

42. A wind turbine has blade radius 30 m, wind speed $14\ \text{ms}^{-1}$, air density $1.2\ \text{kgm}^{-3}$, efficiency 35%. Find output power in kW.

(A) 348.5 kW (B) 3485.6 kW

(C) 116.2 kW (D) 1629.3 kW

43. For a freely falling body of mass m, find the potential energy lost in the n-th second.

(A) mg^2n^2 (B) $\frac{1}{2}mg^2(2n+1)$

(C) $mg^2(2n-1)$ (D) $\frac{1}{2}mg^2(2n-1)$

44. A 1200 kg car brakes from $30\ \text{ms}^{-1}$ to stop. If $\mu = 0.55$, find the stopping distance.

(A) 83.5 m (B) 5.57 m (C) 41.7 m (D) 25.0 m

45. A person climbs to the 6th floor in 2.5 minutes. Steps per floor = $4n + 3$, each step 14 cm, mass 70 kg. Find the power in horsepower.

(A) 70.32 HP (B) 0.0876 HP (C) 0.0167 HP (D) 5.66 HP

46. A satellite's orbital radius is reduced to $\frac{1}{9}$. How does the period change?

(A) $\frac{1}{3}$ (B) $\frac{1}{27}$ (C) $\frac{1}{9}$ (D) $\frac{1}{81}$

47. Mass of planet A is 8 times B, distance is 1.2×10^5 km. What is the distance between the $E = 0$ point and the V_{min} point?

(A) 32920 km (B) 87080 km

(C) 0 (same point) (D) 60000 km

48. Momentum of a 5 kg object is $p(t) = 4t^2 + 3t$ (SI units). Find the work done from $t = 2$ s to $t = 4$ s.

(A) 529.2 J (B) 184.6 J (C) 106.8 J (D) 368.8 J

49. Water falls 50 m at 250000 kg per minute. Turbine 85%, generator 92% efficient. Find output in MW.

(A) 91.25 MW (B) 1.597 MW (C) 1.607 MW (D) 1.691 MW

50. At what distance from Earth's center will g be half of the surface value?

(A) 2R (B) $\frac{R}{2}$ (C) $\sqrt{2}R$ or $\frac{R}{2}$ (D) R