Gravitational Potential Energy Practice Name:____________________________

$m_{Earth} = 5.97 \times 10^{24}$kg $r_{Earth} = 6371$ km

Reflection and Self-Assessment

Completion: Circle the statement that best describes the completion of this practice.

- I completed every question on the practice.
- I did not complete some questions on the practice because:

  ____

Answer Checking: Circle the statement that best describes how you checked your answers

- I checked all my answers against the key at the back and corrected any that were incorrect.
- I did not check all my answers and correct any mistakes because:

  ____

Online Worked Solution: Circle the statement that best describes how you used the online worked solutions.

- I did not use the online worked solution at all.
- I used the online solution to understand some questions I got incorrect.
- I used the online solution to help me learn how to answer some questions.

Confidence: Circle the statement that best describes your confidence in answering questions of this type in the future.

- I am confident I can answer nearly any question of this type correctly without using notes or other assistance.
- I am confident I can answer **MOST** questions of this type correctly without using notes or other assistance.
- I am **NOT** confident I can answer most questions of this type correctly without using notes or other assistance.

Time: Circle the statement below that best describes the total amount of time you spent actively working on this practice:

Less than an hour	Between one and two hours	Between two and three hours	Between three and four hours	More than four hours

Gravitational Potential Energy Practice Name:______________________________

$m_{Earth} = 5.97 \times 10^{24}$kg $r_{Earth} = 6371$ km

1. A 1500 kg satellite is launched into space from the surface of Earth.
   a. What is the gravitational potential energy (relative to infinite) of the satellite when it is on the surface of Earth?

   b. What is the gravitational potential energy (relative to infinite) of the satellite when it is 530 km above the surface of the Earth?

   c. What is the minimum amount of work needed to raise the satellite to that height?

   d. How much different is your answer from c to what you would get using $E_p = mgh$ with g = 9.8m/s^2 ?

Gravitational Potential Energy Practice Name:______________________________

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2. A 235 kg satellite is launched into space from the surface of Earth.
    a. What is the gravitational potential energy (relative to infinite) of the satellite when it is on the surface of Earth?

    b. What is the gravitational potential energy (relative to infinite) of the satellite when it is 55 530 km above the surface of the Earth?

    c. What is the minimum amount of work needed to raise the satellite to that height?

    d. How much different is your answer from c to what you would get using $E_p = mgh$ with g = 9.8m/s^2 ?

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3. A 2.0 kg hammer is placed 12 000 km above the surface of the Earth with an initial velocity of zero. Assuming no energy is lost to friction, how much kinetic energy will it have when it reaches the surface of Earth?

4. A 2.0 kg hammer is placed a very long distance away from Earth (treat the distance as being infinitely far) with an initial velocity of zero. Assuming no energy is lost to friction, how much kinetic energy will it have when it reaches the surface of Earth?

Gravitational Potential Energy Practice Name:_____________________________

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5. A 560 kg satellite is launched into space.
   a. What is the potential energy (relative to infinite) of the satellite when it is on the surface of Earth?

   b. What is the potential energy of the satellite when it is 12 000 km above the surface of the planet?

   c. If the satellite is in uniform circular motion during its orbit, how fast is it moving?

   d. How much kinetic energy does the satellite have when it is in orbit.

   e. How much work must be done to lift the satellite into its orbit and give it enough velocity to stay in the orbit?

Gravitational Potential Energy Practice Name:_____________________________

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6. Two 1.0 kg balls of radius 0.10 metres are placed very far apart (treat as infinitely far apart) in empty space, each with an initial velocity of zero. How fast will each be moving when they finally collide with each other?

7. A person stands on an asteroid of radius 25 km which has a mass of 5.6×10^{15} kg. If they throw a baseball of mass 0.142 kg at a speed of 3.0 m/s upwards how far above the asteroid does it travel before it is pulled back by gravity?

Gravitational Potential Energy Practice Name:_______________________________

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8. A person stands on an asteroid of radius 25 km which has a mass of 5.6×10^{15} kg. If they throw a baseball of mass 0.142 kg at a speed of 25.0 m/s upwards how far above the asteroid does it travel before it is pulled back by gravity (or will it ever be pulled back)?

9. A person stands on an asteroid of radius 25 km which has a mass of 5.6×10^{15} kg. What is the minimum speed they could throw a 0.142 kg baseball so the baseball NEVER comes back?

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10. What is the escape velocity for an object moving away from the surface of the Moon. The mass of the Moon is 7.34×10^{22} kg and its radius is 1737 km.

11. What velocity must an object be moving at Earth's distance from the Sun (151 million km) so that it will not return to the solar system? (Mass of the Sun is about 2.0×10^{30} kg)

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12. A 250 kg satellite is orbiting in a circular orbit, 17 000 km above the surface of the Earth.
    a. What is the velocity of the satellite?

    b. How much kinetic energy does the satellite have?

    c. How much gravitational potential energy (relative to infinite) does the satellite have?

    d. What is the total energy (both kinetic and potential relative to infinite) of the satellite?

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13. The satellite in question 12 is raised from its orbit of 17 000 km to an orbit of 25 000 km above the surface of the Earth.
    a. What is the new velocity of the satellite?

    b. Did the velocity increase or decrease when its orbital radius increased?

    c. What is the new kinetic energy of the satellite?

    d. What is the new potential energy relative to infinite of the satellite?

    e. What is the new total energy of the satellite?

    f. How much work must be done to raise the orbit of the satellite?

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14. A 5500 kg rocket is launched upwards from Earth's surface, it outputs a constant force of 56 000 N, the rocket travels 650 km straight up above the surface of the planet. Ignoring air resistance, what is its speed at this point?

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Answers				
1a) -9.4×10^{10} J	1b) -8.7×10^{10} J	1c) 7.2×10^{9} J	1d) Answer would be 590 000 000 J too much	2a) -1.47×10^{10} J
2b) -1.51×10^{9} J	2c) 1.32×10^{10} J	2d) Almost 10 times too high if you used mgh	3) 8.2×10^{7} J	4) 1.25×10^{8} J
5a) -3.50×10^{10} J	5b) -1.21×10^{10} J	5c) 4700 m/s	5d) 6.1×10^{9} J	5e) 2.9×10^{10} J
6) 3.7×10^{-5} m/s	7) 11 000 m			
8) It will never come back	9) 5.5 m/s	10) 2370 m/s	11) 42 000 m/s	12a) 4.129×10^{3} m/s
12b) 2.13×10^{9} J	12c) -4.26×10^{9} J	12d) -2.13×10^{9} J	13a) 3564 m/s	13b) decrease
13c) 1.59×10^{9} J	13d) -3.18×10^{9} J	13e) -1.59×10^{9} J	13f) 5.4×10^{8} J	14) 1300 m/s