

**Astronomy 2020**  
Homework #1

**Fall 2020**  
**Due: Sep. 9**

Answers to these homework problems will be submitted as hardcopy at the beginning of class on the due date or electronically as a PDF sent via E-mail to Professor Burns by 5 pm on the due date.

1. (5 pts). Let's deconstruct the article that you were given as a homework reading "The elusive why of space exploration". The article claims that we rarely ask why we explore but instead focus more on the tools of exploration. Argue why you think it is or is not important to concentrate on the why. Also, do you agree that the public and the Congress will invest in space by being inspired or aspirational? If not, what justifies the billions in expenditures for NASA?

In questions 2-5 below, choose the best answer. Then **explain** your reasoning in a few complete sentences. Each question is worth **2 points**.

2. Which of the following statements is *not* one of Newton's laws of motion?
  - a. What goes up must come down.
  - b. The rate of change of momentum of an object is equal to the net force applied to the object.
  - c. In the absence of a net force, an object moves with constant velocity.
  - d. For any force, there always is an equal and opposite reaction force.
  - e. All of the above are Newton's laws of motion.
3. How does the Space Shuttle take off?
  - a. Its rocket engines push against the launch pad propelling the shuttle upwards.
  - b. It converts mass-energy to kinetic energy.
  - c. It achieves lift from its wings in the same way that airplanes do.
  - d. Hot gas shoots out from the rocket and, by conservation of momentum, the shuttle moves in the opposite direction.
  - e. The hot rocket exhaust expands the air beneath the shuttle, propelling it forward.

**COMMENTARY** Sandra Magnus and Jack Burns

## The elusive 'why' of space exploration

For those of us in the space sector, we rarely spend time asking "why go to space." The answer is so obvious, so much a part of our DNA, that we don't need to spend time articulating, or even discussing amongst ourselves the "why."

Unfortunately, as a community, we take the "why" so much for granted that when we reach out to connect with those outside of our space tribe — such as our national leadership (whether that is Congress or the administration), or our colleagues from other economic spheres, or to the public — we stumble to deliver a coherent narrative to explain the importance of human expansion into space.

Instead, we dive straight into the gory details of the "how" and describe with passion and excruciating detail all the hardware we need and are building to achieve our endeavors. We talk about rockets, space stations, space vehicles, habitats, fueling depots, resource extraction equipment, life support, and so on. And then we don't understand why our audiences are not as excited or inspired about the concept of humans venturing, permanently, beyond our planet's boundaries. Failing to inspire the same excitement in our listeners, we inevita-

**We have, over thousands of years, explored and spread our presence across the planet. It is time to move off the Earth and continue that dynamic throughout the solar system.**

4. If you drop a rock from a great height, about how fast will it be falling after 5 seconds, neglecting air resistance?
- It depends on how heavy it is.
  - It depends on what shape it is.
  - 10 m/s
  - 15 m/s
  - 50 m/s

5. If an astronaut goes on a space walk outside the Space Station, she will quickly float away from the station unless she has a tether holding her to the station.
- true
  - false



6. (6 pts). The escape velocity from the Moon is about 2400 m/sec.
- Using the rocket equation derived in class with a rocket exhaust velocity of 4500 m/sec, calculate the mass fraction of a rocket (ratio of mass in fuel to total mass of rocket + fuel) needed for it to leave the surface of the Moon.
  - Compare this to the mass fraction required to leave Earth where the escape velocity is 11,200 m/sec.
  - From the above calculations, discuss your thoughts on the relative economics of mining water (to make rocket fuel) on the Moon versus carrying it from Earth.

7. (6 pts). Einstein's discovery that energy and mass are equivalent has led to technological developments that are both beneficial and dangerous. List as many of these developments as you can, categorizing them as positive, negative, or neutral. Overall, do you think the human race would be better or worse off if we had never discovered that mass is a form of energy? Defend your position.

