

1. (4 points) In a crash test, a 1000 kg automobile moving at 10 m/s crashes into a brick wall. How much energy goes into demolishing and heating the wall and the auto?

Answer: All the kinetic energy of the car will be converted into the energy going into heating and demolishing the wall and car (plus sound, which we ignore). So $\frac{1}{2}mv^2 = \frac{1}{2}(1000 \text{ kg})(10 \text{ m/s})^2 = 50\,000 \text{ J}$.

2. (3 points) For an object freely falling to Earth, which of the following is true, ignoring air resistance?

- (a) Its kinetic, gravitational, and total energies all increase.
- (b) Kinetic energy increases, gravitational decreases, the total remains constant.**
- (c) Kinetic energy decreases, gravitational increases, the total remains constant.
- (d) None of its energies change: they all remain constant.
- (e) Kinetic, gravitational, and total energy all decrease.

3. (3 points) Since matter is made of electrically charged particles, why don't we and the objects around us feel electric forces all the time?

- (a) Constituents of objects have opposite charges, adding up to electric neutrality overall.**
- (b) The charges need to be activated before we see any effect; normal matter is inert.
- (c) The electric forces are cancelled out by the magnetic forces.
- (d) We *do* feel these forces: that is where gravity comes from.
- (e) Since these forces act in all directions, they push as often as pull, cancelling out.

4. (3 points) Which of the following is *not* an example of electromagnetic waves?

- (a) Radio waves
- (b) Microwaves
- (c) Visible light
- (d) Sound waves**
- (e) X-rays

5. (3 points) Which one is a reason for inverse-square distance dependence in some forces and signal intensities?

- (a) The involution of radio waves is cross-correlated
- (b) Space is three-dimensional**
- (c) Force is mass times acceleration
- (d) Newton's law of gravity
- (e) Quarks are very small

6. (4 points) Give an example that, according to Neil DeGrasse Tyson, is evidence for the universality of physical law. (*Not* his whipped cream floating to the top!)

Answer: Answers will vary, but might include:

- Same sorts of atomic spectra observed throughout the universe.
- Gravity applying the same way to binary stars and binary galaxies.
- Physical constants being the same everywhere observed.