Unit B Review Worksheet **Name:** Answer Key

1. Why was there a societal 'need' for a steam-engine invention? (pg. 142)

Miners used horses to haul buckets of water out of the mines that wasn't needed. They needed a more efficient method for removing water. (wood & charcoal were becoming scarce, needed more fuel to heat homes/industries like iron smelting, glassmaking etc.

2. Name and describe the major steam-engine inventions. State the major flaw in each.

a) Savery ~ invented by Thomas Savery in 1698 to pump water out of mines. (1st successful steam-powered pump).
drawbacks ~ steam wasn't under high enough pressure, so pump could only lift water 6m high.

b) Newcomen ~ Invented by Thomas Newcomen; used steam. A boiler produced the steam that forced a piston up a cylinder, cold water was sprayed on outside of cylinder to condense steam & move piston down the cylinder. (up/down motion drove pump), could pump water higher distances. Drawbacks ~ very inefficient system (heating/cooling), required lots of heat to function, & heating + cooling wore out cylinder.

c) Watt's ~ Invented by James Watt in 1763. Was asked to repair a Newcomen engine & fix the inefficiency of the heating/cooling system, as lots of heat was being wasted. So he made a seperate condenser to cool the cylinder so the boiler cylinder always remained hot. Drawbacks ~ boilers were too large, however it was still rather inefficient at turning thermal energy into work.

3. Describe the different theories of heat

a) Caloric ~ proposed that the caloric - or heat - was a "massless fluid" and was found in all substances & always flowed from warmer objects to cooler objects.
– friction!

b) Phlogiston ~ states that all substances capable of burning contained an invisible liquid / fluid called "phlogiston", that flowed out while something burned.
– Certain substances (magnesium) have a larger mass of ashes after being burned...

molecules of gas are in constant motion.

* c) Kinetic Molecular Theory ~ all gases consist of particles (atoms/molecules), the particles are in constant motion, volume is determined by container, particles do NOT lose kinetic energy by colliding with eachother, "for ideal gases only" the forces between particles are negligible, & on average at the same temp, speed of molecules will be the same for a given molecule of the same size in Kelvin degrees!

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4. What is the engine type found in modern vehicles?

The type of engine found in modern vehicles is the internal combustion engine.

5. Define the following terms:

a) Motion ~ is the changing in position of an object relative to a reference point.

b) Uniform Motion ~ is the term used to describe an object that is travelling at a constant rate of motion in a straight line.

c) Average Speed ~ is the distance travelled by an object in a specific time, scalar quantity $\left\{ v = \frac{\Delta d}{\Delta t} \right\}$ uses distance & time.

d) Average Velocity ~ uses displacement, & is a vector quantity

$$\left\{ \vec{v} = \frac{\vec{\Delta d}}{\Delta t} \right\}$$

e) Scalar ~ a quantity describing magnitude (size or amount), but not direction. (time, distance, & average speed)

f) Vector ~ a quantity describing both direction and magnitude. (displacement, average velocity, acceleration.)

g) Distance ~ measurement of an object's movement (total)

h) Displacement ~ measurement of an object's travel and the direction of travel (shortest distance from start to finish).

i) Acceleration ~ the change of an object's speed or velocity during a time interval.

$$\left\{ \vec{a} = \frac{\vec{\Delta V}}{\Delta t} \right\}$$

j) Work ~ the transfer of mechanical energy from one object to another; mathematically defined as force times distance. ($f \times d = w$)

* k) Force = $F = \frac{w}{d}$ measured in Newtons. $F = \frac{w}{d}$

Same as weight

$$= \begin{cases} F_g = m \times g \\ = \text{weight} \end{cases}$$

6. An object is traveling at an average speed of 8.0 m/s. How long will it take this object to travel 30.5 m?

$v = \frac{\Delta d}{\Delta t}$, $t = \frac{d}{v}$

$t = \frac{30.5}{8.0}$, $t = 3.8125$

$d = 30.5\ m$

$v = 8.0\ m/s$ ✓

$\boxed{t = 3.8\ s}$

7. An object is traveling at an average speed of 12.5 m/s. How far will this object travel in 8.6 s?

$v = \frac{\Delta d}{\Delta t}$, $d = v \times t$

$d = 12.5 \times 8.6 = 107.5$

$v = 12.5\ m/s$

$t = 8.6\ s$ ✓

$\boxed{d = 1.1 \times 10^2\ m}$

8. An object is dropped from a height of 65.0 m. If the object takes 3.62s to fall, what is the average speed of the object?

$v = \frac{\Delta d}{\Delta t}$, $v = \frac{65.0\ m}{3.62\ s}$, $v = 17.955801...$

$d = 65.0\ m$

$t = 3.62\ s$ ✓

$\boxed{v = 18.0\ m/s}$

9. If you run 9.0 km/h for 30 minutes, how much distance will you cover?

$9.0 \times 1000 = \frac{9000}{3600} = 2.5\ m/s$

$30 \times 60 = 1800\ s$

$d = v \times t$, so $2.5 \times 1800 = 4500$ ✓ $\boxed{d = 4.5 \times 10^3\ m}$

10. What can you determine from a Distance-Time Graph? A Speed-Time Graph? How?

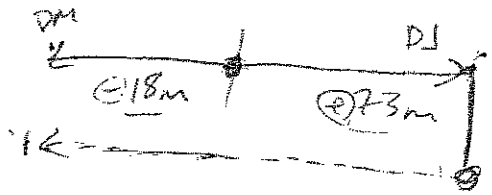
A ~ You can determine average speed, by using slope = $\frac{rise}{run}$
~ calculating slope of a line allows us to graphically determine average speed $v = \frac{d}{t}$

B ~ You can determine velocity, and determine the distance travelled by calculating the area under the line of the graph. ($d = v \times t$) ✓

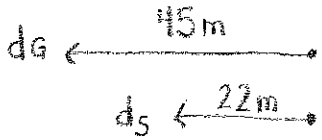
11. Jessica is standing at a position described by $\vec{d}_J = +73$ m. Melanie is standing at $\vec{d}_M = -18$ m. What is the displacement from Jessica to Melanie?

$\vec{d} = (18) + (73) = 55$

$\vec{d} = -91$ m [S]

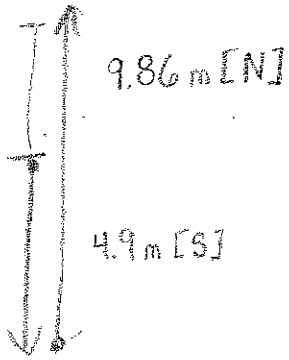


12. Grant is standing at position $\vec{d}_G = 45$ m [W] and Serina is at position $\vec{d}_S = 22$ m [W]. What is the displacement from Grant to Serina?



$\vec{d} = +23$ m [E] from Grant → Serina

13. Sally displaces 4.9 m [S] and then 9.86 m [N]. What is her total displacement?



$\vec{d} = 9.86 - 4.9 = 5.0$ m

$\vec{d} = 5.0$ m [N]

10. A student walks 10.0 m [E] in 7.00 s. What is the student's average velocity?
Don't forget to include direction in your answer

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$, $\vec{v} = \frac{10.0\text{ m}}{7.00\text{ s}}$, $\vec{v} = 1.428571429...$

$\vec{v} = 1.43$ m/s [E]

11. The acceleration of the space shuttle at takeoff is 29 m/s^2. What is the shuttle's velocity after 12s?

$\vec{a} = \frac{\Delta \vec{V}}{\Delta t}$, $\Delta \vec{V} = \vec{a} \times \Delta t$, $\Delta \vec{V} = 29\ m/s^2 \times 12s$

$\Delta \vec{V} = 348$, $\boxed{\Delta \vec{V} = 3.5 \times 10^2\ m/s}$ upward

12. A weightlifter lifts a barbell a vertical distance of 2.40m. If the average force required to lift the barbell is 2.00 x 103N, how much work is done by the weightlifter?

10^3

$W = f \times d$ $W = 2000 \times 2.40 = 4800$

$f = 2.00 \times 10^3 = 2000N$

$d = 2.40m$ $\boxed{W = 4.80 \times 10^3\ J}$

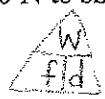
13. A force of 50 N acts to push an object 6.0 m. How much work is being done?

$W = f \times d$ $W = 50 \times 6.0 = 300$

$f = 50N$

$d = 6.0m$ $\boxed{W = 3.0 \times 10^2\ J}$

14. A student applies a force of 6.0 N to slide a book across a desk. If the student does 1.98 J of work on the book, how far did it move?



$W = f \times d$

$W = 1.98\ J$ so, $d = \frac{W}{f}$, so $d = \frac{1.98}{6.0} = 0.33\ m$

$f = 6.0N$

$d = ?$ $\boxed{d = 0.33m}$

15. Define the following terms:

a) Chemical Energy ~ the energy stored in the chemical bonds of compounds.

b) Electrical Energy ~ energy produced by moving electrons.

c) Nuclear Energy ~ potential energy stored in the nucleus of an atom.

d) Solar Energy ~ results from a hydrogen - hydrogen nuclear fusion bond.

e) Potential Energy ~ energy stored in a substance or object due to its position or condition.

f) Kinetic Energy ~ the energy of motion / energy it possesses due to motion. (work needed to accelerate a body of mass from rest to a stated velocity.)

16. Name and describe the 4 different types of potential energy.

~ Elastic potential energy ~ the energy stored in an elastic object when work is done to distort the shape of the object.

~ chemical potential energy ~ energy stored in chemical bonds of compounds.

~ nuclear potential energy ~ energy stored in the nucleus of an atom; when rearranged HUGE energy is produced.

~ Gravitational Potential energy ~ energy stored in an object as a result of its height or vertical position.

17. A 800 g bird has 47.0 J of gravitational potential energy when it is perched high up in a tree. Calculate the bird's height from the ground.

$E_{g(p)} = mg\Delta h$ / $h = \frac{E_{g(p)}}{mg}$ so, $\frac{47.0\ J}{0.8 \times 9.81} = 5.988786952...$

$m = 800g \div 1000 = 0.8\ kg$

$g = 9.81\ m/s^2$

$\Delta h = ?$

$E_g = 47.0\ J$

$\boxed{\Delta h = 5.99\ m}$ ✓

18. A child with a mass of 25.0 kg is at the top of a slide in an amusement park. If the vertical height of the slide is 4.00 m, what is the gravitation potential energy of the child relative to the ground?

$E_{g(p)} = mg\Delta h$

$m = 25.0\ kg$

$g = 9.81\ m/s^2$

$\Delta h = 4.00\ m$

$E_{g(p)} = 25.0\ kg \times 9.81\ m/s^2 \times 4.00\ m$

$= 981$

$\boxed{E_{g(p)} = 981\ J}$ ✓

19. The kinetic energy of an object moving at a speed of 14.2 m/s was determined to be 950 J. What is the mass of the object?

$E_k = \frac{1}{2} mv^2$ / $m = \frac{2E_k}{v^2}$ so, $950 \times 2 = \frac{1900\ J}{14.2^2} = 9.422733585...$

$m = ?$

$v = 14.2\ m/s$

$E_k = 950\ J$

$\boxed{m = 9.42\ kg}$ ✓

20. What is the speed of an 800 kg automobile if it has a kinetic energy of 9.00×10^4 J?

$E_k = \frac{1}{2} mv^2$ / $v = \sqrt{\frac{2E_k}{m}}$ so, $90\,000 \times 2 = \frac{180\,000}{800}$

$m = 800\ kg$

$= \sqrt{225} = 15$

$E_k = 9.00 \times 10^4 = 90\,000\ J$

$v = ?$

$\boxed{v = 15.0\ m/s}$ ✓

✳ (21.) A .500 kg baseball is thrown in a straight line through the air. At a height of 2.70 m above the surface of Earth, it has a speed of 20.0 m/s. What is the total mechanical energy of the baseball?

$E_m = E_k + E_{g(p)}$

$E_k = \frac{1}{2}mv^2$, so $0.5 \times 0.500\ kg \times 20.0\ m/s^2 = 100J$

$E_{g(p)} = mg\Delta h$, so $0.500 \times 9.81 \times 2.70 = 13.2435\ J$

$+ = 113.2435$

$= 113$

$E_m = 113J$

22. State the two Laws of Thermodynamics.

1. Energy cannot be created or destroyed, but can be transferred from one form to another or transferred from one thing to another.

2. Cannot convert 100% thermal energy to work.

23. What is the formula for calculating efficiency?

$$\text{Efficiency} = \frac{\text{useful output energy}}{\text{total input energy}} \times 100$$

(24.) A small electric motor has an efficiency of 85%. In lifting a small load, it produces 15 J of mechanical energy input. Calculate the useful mechanical energy output of the motor.

$85\% = 0.85 = \frac{x}{15J}$ (×15 on the left, ×5 on the right)

$x = 12.75 = 13$

the useful mechanical energy output = $\boxed{13J}$

25. In lifting a car, the total mechanical energy input of hydraulic hoist is 5.61×10^4 J, while the useful mechanical energy output is 1.96×10^4 J. Calculate the percent efficiency of the hoist.

input $= 5.61 \times 10^4 = 56100J$

output $= 1.96 \times 10^4 = 19600J$

$= \frac{19600}{56100} \times 100 = 34.93761141...$

Efficiency = 34.9%