Exam Review (yr long) Jan 2016

Key Terms

- Frame of reference
- Position
- Distance
- Scalar
- Vector
- Displacement
- Time interval
- Average velocity
- Constant velocity
- Position-time graph
- Speed
- Velocity
- Instantaneous velocity
- Velocity-time graph
- Constant acceleration
- Initial velocity
- Final velocity
- Gravitational force
- Friction
- Static friction
- kinetic friction
- Coefficient of friction
- Force
- Weight
- Momentum
- Impulse
- Momentum-Impulse theorem
- Work
- Power
- Kinetic energy
- Potential energy
- Work-energy theorem
- Transverse waves
- Longitudinal waves
- Wave pulse
- Period
- Frequency
- Wavelength
- Crest
- Trough
- Amplitude
- Normal
- Angle of incidence
- Angle of reflection
- Law of reflection
- Angle of refraction
- Refractions
- Diffraction
- Doppler shift
- Pitch
- Loudness
- Ray
- Diffuse reflection
- Regular reflection
- Optically dense
- Snell's law
- Index of refraction
- Total internal reflection
- Critical angle

Unit 1- Kinematics

1. Name 3 scalar and vector quantities
   Scalar: Time, distance, speed
   Vector: displacement, velocity, acceleration, force
2. Explain the difference between:
   a. Distance vs displacement
      Distance is ground covered direction does not matter, where as displacement is how far you are from you starting position and in what direction.
   b. Speed vs Velocity
      Speed is distance over time and is a scalar quantity how fast, where as velocity is displacement over time and is a vector quantity how fast and in what direction.

Problems

3. Convert the following times. All units must be shown as well as cancellations.
   a. 20 minutes to seconds
      $20min \times \frac{60s}{1min} = 1200s$
   b. 6.5 hours to minutes
      $6.5h \times \frac{60min}{1h} = 390\ min$

c. 0.6 days to hours

$0.6\ d \times \frac{24h}{1d} = 14.4\ h$

d. 4.5 years to seconds

$4.5yr \times \frac{365d}{1yr} \times \frac{24h}{1d} \times \frac{3600s}{1h}$

$= 141\ 912\ 000s$

e. 453 seconds to hours

$453s \times \frac{1h}{3600s} = 0.12583\ h$

f. 0.35 minutes to year

$0.35min \times \frac{1h}{60min} \times \frac{1d}{24h} \times \frac{1yr}{365d}$

$= 6.659 \times 10^{-7} yr$

4. Convert the following speeds. Show all units as well as cancellations.

a. 25 km/h to m/s

$\frac{25km}{h} \times \frac{1000m}{1km} \times \frac{1h}{3600s}$

$= 6.94\ m/s$

b. 150 km/h to m/s

$\frac{150km}{h} \times \frac{1000m}{1km} \times \frac{1h}{3600s}$

$= 41.7m/s$

c. 2.0 m/s to km/h

$\frac{2.0m}{s} \times \frac{1km}{1000m} \times \frac{3600s}{1h}$

$= 7.2\ km/h$

d. 50 m/s to km/h

$\frac{50m}{s} \times \frac{1km}{1000m} \times \frac{3600s}{1h}$

$= 180km/h$

5. A sneeze causes you to momentarily shut your eyes. If this process takes 0.5 s and you are moving at 30 km/h, how far will you travel in that time?

$t = 0.5s$

$v = 30km/h \div 3.6 = 8.3\ m/s$

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

$d = vt$

$d = (8.3)(0.5)$

$= 4.16m = 4m$

6. If Donovan Bailey reaches a top speed from rest of 10.2 m/s in 2.5 s, what is his acceleration?

$v_i = 0m/s$

$v_f = 10.2m/s$

$t = 2.5s$

$a = ?$

$a = \frac{v_f - v_i}{t}$

$a = \frac{10.2-0}{2.5} = 4.08m/s^2 = 4.1m/s^2$

7. If a sprinter accelerates at 2.2 m/s^2 for 2.5 s, what is her velocity after this time, assuming initial v=0m/s?

$a = 2.2m/s^2$

$t = 2.5s$

$v_i = 0m/s$

$v_f = ?$

$a = \frac{v_f - v_i}{t}$

$at = v_f - v_i$

$v_f = at + v_i$

$v_f = (2.2)(2.5) + 0$

$v_f = 5.5m/s$

8. A confused person walks 5.7 km towards the east in 2.75 h, then 1.0 km towards the west in 0.50 h, and finally 12.5 km towards the east in 2.5 h.

$d1 = 5.7km\ east$ $t1 = 2.75\ h$

$d2 = 1.0km\ west$ $t2 = 0.50h$

$d3 = 12.5km\ east$ $t3 = 2.5h$

a. What is the person's average speed?

$v_{avg} = \frac{d_t}{t_t}$

$d_t = 5.7 + 1.0 + 12.5 = 19.2\ km$

$t_t = 2.75 + 0.50 + 2.5 = 5.75h$

$v_{avg} = \frac{19.2}{5.75} = 3.339\ km/h$

$3.3km/h$

b. What is the person's average velocity?

$\vec{v}_{avg} = \frac{\vec{d}_t}{t_t}$

$\vec{d}_t = 5.7 - 1.0 + 12.5 = 17.2\ km$

$t_t = 2.75 + 0.50 + 2.5 = 5.75h$

$\vec{v}_{avg} = \frac{17.2}{5.75} = 2.991km/h$ East

$3.0km/h$ East

9. A train travels 58 km at an average velocity of 77 km/h east, waits for 5.0 min at a station and then runs for half an hour at an average velocity of 64 km/h east. Find the average velocity for the whole trip.

Part 1

$d = 58\ km$

$v = 77km/h$

$t = ?$

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

$t = \frac{58}{77} = 0.753\ h$

Part 2

$d = 0\ km$

$v = 0km/h$

$t = 5.0min = 0.0833h$

Part 3

$d = ?$

$v = 64km/h$

$t = 0.5h$

$d = vt$

$d = (64)(0.5)$

$d = 32m$

$$\vec{v}_{avg} = \frac{\vec{d}_t}{t_t} = \frac{58 + 0 + 32}{0.753 + 0.0833 + 0.5} = 67.35 = 67km/h$$

10. Nick is walking east to meet his friend Brendan, who lives 2.0 km away. Nick has a speed of 5.0 m/s. If Brendan leaves his home to meet Nick at the same time but is only travelling 3.5 m/s west:

$v_{Nick} = 5.0\ m/s$

$v_{Brendan} = -3.5m/s$

$d_r = 2.0km = 2000m$

$v_{NB} = 5.0 - (-3.5) = 8.5\ m/s$

a. How long will it take them to meet?

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

$t = \frac{2000}{8.5} = 235.29s = 240s$

b. How far will Brendan have travelled when they meet?

$d = vt$

$d = (3.5)(235.29)$

$d = 823.515m = 820m$

11. Amanda and Erin are racing their cars on a track at one point Amanda is 1.50 km behind Erin. Erin is travelling at 100. km/h and Amanda is travelling at 125. km/h.

$v_{Erin} = 100.\ km/h$

$v_{Amanda} = 125km/h$

$d_r = 1.50\ km$

$v_{AE} = 125 - 100 = 25km/h$

a. How long will it take Amanda to catch Erin?

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

$t = \frac{1.50}{25} = 0.06h = 0.0600h$

b. How far will Amanda travel to catch you?

$d = vt$

$d = (125)(0.0600)$

$d = 7.5km = 7.50km$

12. Michael leaves Dalhousie Junction travelling toward Campbellton at 107 km/h. Trevor leaves Campbellton travelling towards Dalhousie Junction at 99km/h. The distance between Campbellton and Dalhousie Junction is 55 km.

$v_{Michael} = 107km/h$

$v_{Trevor} = 99km/h$

$d_r = 55\ km$

$v_{MT} = 107 - (-99) = 206km/h$

a. If both cars leave at the same time, how far from Campbellton will they meet?

$t = \frac{d}{v} = \frac{55}{206} = 0.26699h$

$d = vt$

$d = (99)(0.26699) = 26.43\ km = 26km$

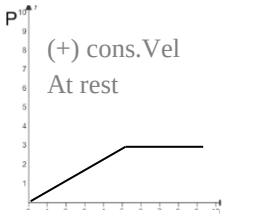
b. If the car from Campbellton leaves 5.0 minutes before the car from Dalhousie Junction, how far from Dalhousie Junciton will they meet?

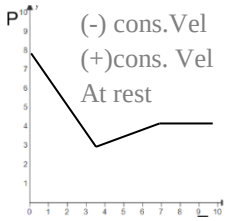
$t = 5.0\ min = 0.0833\ h$
$d_{Trevor} = vt$
$d_{Trevor} = (99)(0.0833) = 8.25km$
$d_r = 55 - 8.25 = 46.75\ km$
$t = \frac{d}{v} = \frac{46.75}{206} = 0.2269h$
$d = vt$
$d = (107)(0.2269) = 24.28\ km = 24km$

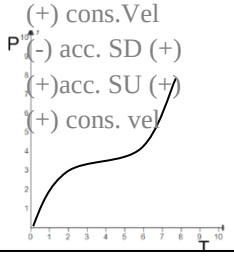
13. Jonah is running at a constant velocity of 3.0 m/s east. Eva is running at a constant velocity of 4.5 m/s in the same direction, but Eva started running 2.0 minute after Jonah. Assuming that they started from the same location, how long will it take Eva to catch Jonah?

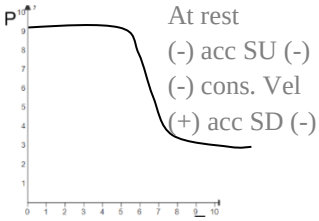
$v_{Jonah} = 3.0\ m/s$
$v_{Eva} = 4.5m/s$
$t_j = 2.0min = 120s$
$d_r = vt$
$d_r = (3.0)(120) = 360\ m$
$v_{EJ} = 4.5 - 3.0 = 1.5\ m/s$
$t = \frac{d}{v} = \frac{360}{1.5} = 240s$

14. a. Describe each of the following graphs
    b. Draw an equivalent position or velocity time graph for each









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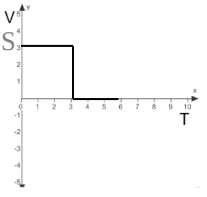
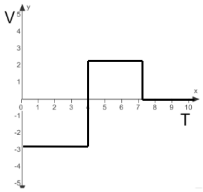
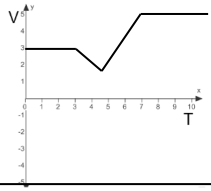
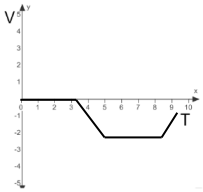
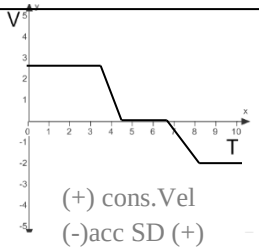


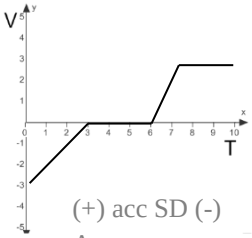




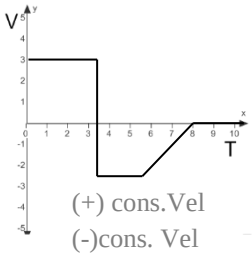




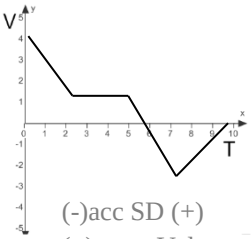
(+) cons.Vel
(-)acc SD (+)
At rest
(-)acc SU (-)
(-) cons. Vel



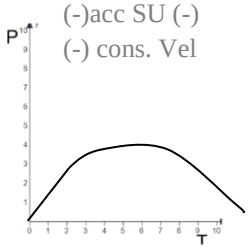
(+) acc SD (-)
At rest
(+) acc SU (+)
(+) cons. Vel

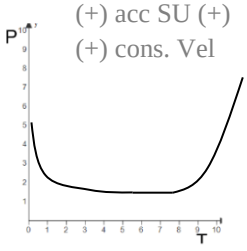


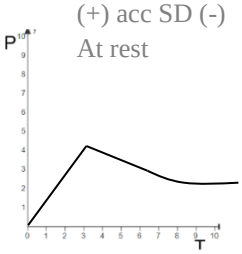
(+) cons.Vel
(-)cons. Vel
(+) acc SD (-)
At rest

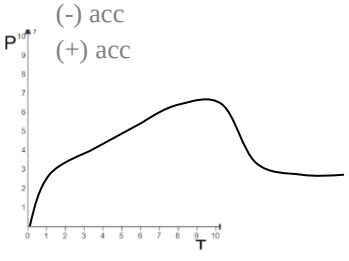


(-)acc SD (+)
(+)cons. Vel
(-) acc
(+) acc

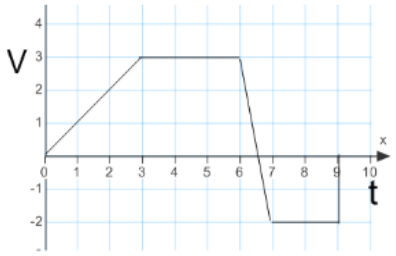








15. What is the displacement of the following objects



$\Delta A = \frac{bh}{2}$

$\Delta A = \frac{(3)(3)}{2} = 4.5$

■$A = bh$

■$A = (3)(3) = 9$

$\Delta A = \frac{bh}{2}$

$\Delta A = \frac{(0.5)(3)}{2} = 1.5$

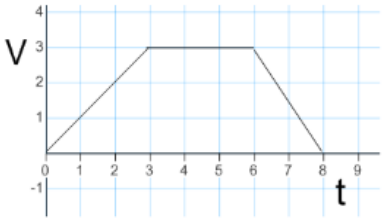
$\Delta A = \frac{bh}{2}$

$\Delta A = \frac{(0.5)(-2)}{2} = -0.5$

■$A = bh$

■$A = (2)(-2) = -4$

$Displacement = 4.5 + 9 + 1.5 - 0.5 - 4 = 10.5$



$\Delta A = \frac{bh}{2}$

$\Delta A = \frac{(3)(3)}{2} = 4.5$

■$A = bh$

■$A = (3)(3) = 9$

$\Delta A = \frac{bh}{2}$

$\Delta A = \frac{(2)(3)}{2} = 3$

$Displacement = 4.5 + 9 + +3 = 17.5$

16. A certain brand of car can accelerate from 0 to 60 km/h in 4.20 s. What is it's acceleration? How far did it travel?

$v_i = 0km/h$

$v_f = 60km/h = 16.67m/s$

$t = 4.20s$

$a = ?$

$d = ?$

$a = \frac{v_f - v_i}{t}$

$a = \frac{16.67 - 0}{4.20} = 3.968 = 4m/s^2$

$d = v_i t + \frac{1}{2}at^2$

$d = \frac{1}{2}(3.968)(4.20)^2$

$d = 34.99m = 30\ m$

17. A bullet in a rifle accelerates uniformly from rest at a = 70 000 m/s^2 barrel. If the bullet leaves muzzle at a velocity of 500. m/s, how long is the rifle barrel? How long did it take for the bullet to travel the length of the barrel?

$v_i = 0m/s$

$v_f = 500.m/s$

$a = 70\ 000m/s^2$

$t = ?$

$v_f^2 = v_i^2 + 2ad$

$d = \frac{v_f^2 - v_i^2}{2a}$

$d = \frac{500^2 - 0}{2(70000)} = 1.79m$

$a = \frac{v_f - v_i}{t}$

$t = \frac{v_f - v_i}{a}$

$t = \frac{500 - 0}{70\ 000} = 0.00714s$

$= 0.007s$

18. A Ferrari, moving at 20.0 km/h, accelerates to 230 km/h in 7.50 s. Find the distance travelled. Calculate the acceleration.

$v_i = 20.0km/h$=5.556m/s

$v_f = 230km/h$=63.89 m/s

$t = 7.50s$

$d = ?$

$d = \left(\frac{v_i + v_f}{2}\right)t$

$d = \left(\frac{5.556 + 63.89}{2}\right)7.50\ = 260.418\ m = 260m$

19. Jane Bond runs down the sidewalk, accelerating uniformly at a rate of 0.20 m/s^{2}from her initial velocity of 3.0 m/s. How long will it take Jane to travel a distance of 12m?

$v_i = 3.0m/s$
$a = 0.20m/s^2$
$d = 12m$
$t = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$12 = (3.0)t + \frac{1}{2}(0.20)t^2$$
$$0.1t^2 + 3.0t - 12 = 0$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$t = \frac{-3.0 \pm \sqrt{3.0^2 - 4(0.1)(-12)}}{2(0.1)}$$
$$t = \frac{-3.0 \pm \sqrt{9 + 4.8}}{0.2} = \frac{-3 \pm 3.715}{0.2}$$
$$t = 3.574s = 3.6s$$

20. Jack, who is running at 9.0 m/s to catch a bus, sees it start to move when he is 20m away from it. If the bus accelerates at 2.0 m/s^2, will Jack overtake it? If so, how long will it take him?

Jack
$v = 9.0m/s$
$d = 20 + x$
$t = t$
$d = vt$
$20 + x = (9.0)t$

Bus
$v_i = 0$
$a = 2.0m/s^2$
$d = x$
$t = t$

$$d = v_i t + \frac{1}{2}at^2$$
$$x = \frac{1}{2}(2)t^2$$

$$20 + \frac{1}{2}(2)t^2 = (9.0)t$$
$$20 + t^2 = 9t$$
$$t^2 - 9t + 20 = 0$$
$$(t - 4)(t - 5) = 0$$
$$t = 4s, t = 5s$$

Yes Jack will over take the bus at 4s.

21. An airplane accelerates down a runway at 3.20 m/s^2 for 32.8 s until is finally lifts off the ground. Determine the distance traveled before takeoff.

$a = 3.20\ \mathrm{m/s^2}$
$t = 32.8s$
$v_i = 0m/s$
$d = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$d = \frac{1}{2}(3.20)(32.8)^2$$
$$= 1721.344\ m = 1720m$$

22. A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of 110 m. Determine the acceleration of the car.

$t = 5.21s$
$v_i = 0m/s$
$d = 110m$
$a = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$a = \frac{2d}{t^2}$$
$$a = \frac{2(110)}{(5.21)^2} = 8.1m/s^2$$

23. A feather is dropped on the moon from a height of 1.40 meters. The acceleration of gravity on the moon is 1.67 m/s^2. Determine the time for the feather to fall to the surface of the moon.

$d = -1.40\ m$
$a = -1.67 m/s^2$
$v_i = 0 m/s$
$t = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$-1.40 = 0 + \frac{1}{2}(-1.67)t^2$$
$$t = \sqrt{\frac{(-1.40)(2)}{-1.67}} = 1.29s$$

24. A kangaroo is capable of jumping to a height of 2.62 m. Determine the takeoff speed of the kangaroo.

$d = 2.62\ m$
$a = -9.8 m/s^2$
$v_f = 0$
$v_i = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$v_i^2 = v_f^2 - 2ad$$
$$v_i^2 = 0 - 2(-9.8)(2.62)$$
$$v_i = \pm 7.166 m/s$$
$$v_i = 7.17 m/s$$

25. If Michael Jordan has a vertical leap of 1.29 m, then what is his takeoff speed and his hang time (total time to move upwards to the peak and then return to the ground)?

$d = 1.29\ m$
$a = -9.8 m/s^2$
$v_f = 0$
$v_i = ?$
$t = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$v_i^2 = v_f^2 - 2ad$$
$$v_i^2 = 0 - 2(-9.8)(1.29)$$
$$v_i = \pm 5.028 m/s$$
$$v_i = 5.03 m/s$$

$$a = \frac{v_f - v_i}{t}$$
$$t = \frac{v_f - v_i}{a}$$
$$t = \frac{0 - 5.03}{-9.8} = 0.513s$$
$$hang\ time\ t \times 2$$
$$= 0.513 \times 2 = 1.03s$$

26. A baseball is popped straight up into the air and has a hang-time of 6.25 s. Determine the height to which the ball rises before it reaches its peak. (Hint: the time to rise to the peak is one-half the total hang-time.)

$a = -9.8 m/s^2$
$v_i = 0$
$t = \frac{6.25}{2} = 3.125s$
$d = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$d = \frac{1}{2}(-9.8)(3.125)^2$$
$$d = 47.85\ m = 47.9\ m$$

27. The observation deck of tall skyscraper 370 m above the street. Determine the time required for a penny to free fall from the deck to the street below.

$a = -9.8 m/s^2$
$v_i = 0$
$d = -370\ m$
$t = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$-370 = \frac{1}{2}(-9.8)t^2$$
$$t = \sqrt{\frac{(-370)(2)}{-9.8}} = 8.69s = 8.7s$$

Unit 2 Dynamics

Short Answer

1. Describe how and why acceleration due to gravity varies around the globe.

Acceleration due to gravity is dependent upon the distance from the center of the earth. The earth is shaped like an ellipse with the equator being father from the center than the poles. The closer you are to the center of the earth the greater your acceleration due to gravity will be.

2. A news reporter states that the winning entry in a giant pumpkin-growing contest "had a weight of 354 kg" Explain the error in this statement and provide values for both the weight and mass of the winning pumpkin.

   The reporter is mistaken when he states that the pumpkin has a weight of 354 kg, the pumpkin has a mass of 354kg and a weight of (354)(9.8)=3469.2 N. Mass is what an object is made up of (matter) while weight is how gravity acts on mass.

3. Explain why the coefficient of static friction is greater than the coefficient of kinetic friction.

   The coefficient of static friction is greater than that of kinetic friction because an object at rest has time for bonds to be formed these bonds are harder to break than those of a moving object in which bonds are constantly being formed and broken.

4. You are a passenger in a car that is driving on the highway at 100 km/h. Explain, in terms of inertia, what happens to you if the driver breaks suddenly?

   If the driver suddenly breaks your body is going to resist the change in motion unless acted on by an external force (seat belt) you will keep moving forward until the seat belt stops you.

5. If gold were sold by weight, at which of the two locations would you prefer to buy it: At a location on the equator at sea level or at the North Pole? If it were sold by mass, where would you prefer to buy it? Explain.

   I would want to by the gold at the location that is farthest from the center of the earth therefore having the lowest acceleration due to gravity giving the smallest weight. In this case I would like to buy the gold at the equator.

6. How do you determine the direction of the force of surface friction?

   Friction always acts in the opposite direction of the motion.

Problems

7. What is the mass of a sack of potatoes that weights 1.10 x 10^2 N?

   $f_g = 1.10 \times 10^2 N$
   $g = 9.8 m/s^2$
   $f_g = mg$

   $m = \frac{f_g}{g}$
   $m = \frac{110}{9.8} = 11.2\ kg$

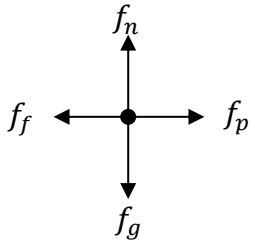
8. If you weight 541 N on earth, how much would you weight on the Moon(1.64 m/s^2)? Mars(3.72 m/s^2)?

   $f_g = 541N$
   $g_{moon} = 1.64 m/s^2$
   $g_{mars} = 3.72 m/s^2$
   $f_g = mg$
   $m = \frac{f_g}{g}$

   $m = \frac{541}{9.8} = 55.20kg$
   $f_g = mg$
   $f_{gmoon} = (55.20)(1.64) = 90.5N$
   $f_{gmars} = (55.20)(3.72) = 205N$

9. You must push with a force of 401 N in order to slide a 47 kg overstuffed chair across the carpet at a constant velocity. What is the coefficient of friction between the chair and the carpet?

   $f_p = 401\ N$
   $m = 47\ kg$
   $a = 0$
   $\mu = ?$



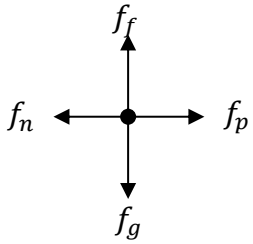
Vertical
$+f_n = ?$
$-f_g = mg$
$= (47)(9.8)$
$= 460.6N$
$f_{net} = ma$
$f_n - f_g = ma$
$f_n - f_g = 0$
$f_n = f_g$
$f_n = 460.6\ N$

Horizontal
$+f_p = 401\ N$
$-f_f = ?$
$f_{net} = ma$
$f_p - f_f = ma$
$f_p - f_f = 0$
$f_p = f_f$
$f_p = 401N$

$f_f = \mu f_n$
$\frac{f_f}{f_n} = \mu$
$\mu = \frac{401}{460.6}$
$\mu = 0.87$

10. You are pushing horizontally on a 3.0 kg block of wood, pressing it against a wall. If the coefficient of static friction between the block and the wall is 0.60, how much force must you exert on the block to prevent it from sliding down the wall?

$m = 3.0\ kg$
$\mu = 0.60$
$f_p = ?$



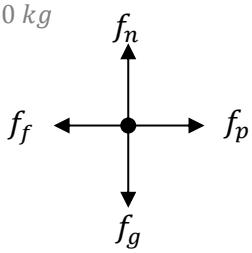
Vertical
$+f_f = ?$
$-f_g = mg$
$= (3.0)(9.8)$
$= 29.4N$
$f_{net} = ma$
$f_f - f_g = ma$
$f_f - f_g = 0$
$f_f = f_g$
$f_f = 29.4\ N$

$f_f = \mu f_n$
$\frac{f_f}{\mu} = f_n$
$f_n = \frac{29.4}{0.60}$
$f_n = 49\ N$

Horizontal
$+f_p = ?$
$-f_n = 49$
$f_{net} = ma$
$f_p - f_n = ma$
$f_p - f_n = 0$
$f_p = f_n$
$f_p = 49N$

11. You are helping a friend push a piano across the floor. It has a mass of 450 kg.
    a. Calculate the normal force supporting the piano.

$m = 450\ kg$



Vertical
$+f_n = ?$
$-f_g = mg$
$= (450)(9.8)$
$= 4410N$

$f_{net} = ma$
$f_n - f_g = ma$
$f_n - f_g = 0$
$f_n = f_g$
$f_n = 4410\ N$

    b. If the coefficient of static friction between the floor and the piano is 0.35, calculate the minimum amount of force needed to start the piano moving.

$f_f = \mu f_n$
$f_f = (0.35)(4410)$
$f_f = 1543.5N$

Horizontal
$+f_p = ?$
$-f_f = 1543.5N$
$f_{net} = ma$
$f_p - f_f = ma$

$f_p - f_f = 0$
$f_p = f_f$
$f_p = 1543.5N$

    c. Once the piano is moving, a horizontal force of 1.1 x 10^3 N is necessary to keep it moving at a constant speed. Determine the coefficient of kinetic friction.

Horizontal
$+f_p = 1100\ N$
$-f_f = ?$
$f_{net} = ma$
$f_p - f_f = ma$

$f_p - f_f = 0$
$f_p = f_f$
$f_f = 1100N$

$f_f = \mu f_n$
$\frac{f_f}{f_n} = \mu$
$\mu = \frac{1100}{4410}$
$\mu = 0.25$

    d. Once moving, what force must be applied to the piano to accelerate it at 3.0 m/s^2?

$f_f = \mu f_n$
$f_f = (0.25)(4410)$
$f_f = 1102.5N$

Horizontal
$+f_p = ?\ N$
$-f_f = 1102.5N$
$f_{net} = ma$
$f_p - f_f = ma$

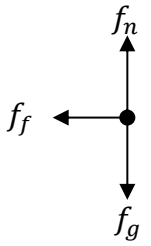
$f_p - f_f = (450)(3.0)$
$f_p = 1350 + 1102.5$
$f_p = 2452.5N$

12. A force of 9000 N is used to stop a 1500 kg car travelling at 20.0 m/s. What braking distance is needed to bring the car to a halt?

$f_f = 9000N$
$m = 1500\ kg$
$v_i = 20.0\ m/s$
$v_f = 0\ m/s$
$d = ?$

Horizontal
$-f_f = 9000N$
$f_{net} = ma$
$-f_f = ma$
$-\frac{f_f}{m} = a$
$a = -\frac{9000}{1500} = -6\ m/s^2$

$v_f^2 = v_i^2 + 2ad$
$d = \frac{v_f^2 - v_i^2}{2a}$
$d = \frac{0 - 20.0^2}{2(-6)} = 33.3m$
$d = 30\ m$



13. The maximum force a grocery bag can withstand and not rip in 250 N. If 20 kg of groceries are lifted from the floor to the table with an acceleration of 5 m/s^2, will the bag hold?

$f_{tmax} = 250N$
$m = 20kg$
$a = 5m/s^2$

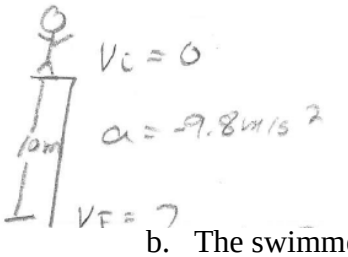
Vertical
$+f_t = ?$
$-f_g = mg$
$= (20)(9.8)$
$= 196N$

$f_{net} = ma$
$f_t - f_g = ma$
$f_t - 196 = (20)(5)$
$f_t = 100 + 196$
$f_f = 296\ N$

The bag will break; force of tension found is greater than the max tension the bag can withstand.

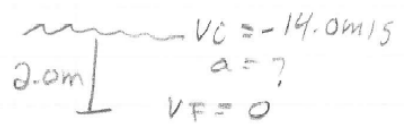
14. A 65 kg swimmer jumps off a 10.0 tower.

a. Find the swimmer's velocity when hitting the water.



$v_f^2 = v_i^2 + 2ad$
$v_f^2 = 0 + 2(-9.8)(-10)$
$v_f = \pm\sqrt{196} = \pm 14 = -14\ m/s$

b. The swimmer comes to a stop 2.0 m below the surface of the water. Find the average net force exerted on the swimmer over this 2.0 m.



$v_f^2 = v_i^2 + 2ad$
$a = \frac{v_f^2 - v_i^2}{2d}$
$a = \frac{0 - (-14)^2}{2(-2.0)} = 49m/s^2$

$f_{net} = ma$
$f_{net} = (65)(49)$
$f_{net} = 3185N = 3200N$

c. Find the force exerted by the water on the swimmer.

$f_w - f_g = ma$
$f_w = ma + f_g$
$f_w = (65)(49) + (65)(9.8)$
$f_w = 3822N = 3800N$

15. An exceptional standing jump would raise a person 0.80 m off the ground. To do this, what force must a 70.0 kg person exert against the ground? Assume the person lowers himself 0.20 m prior to jumping.

air
0.80m
$v_f = 0$
$a = -9.8m/s^2$
$v_i = ?$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 - 2ad = v_i^2$
$v_i^2 = 0 - 2(-9.8)(0.80)$
$v_i = \sqrt{15.68} = 3.96\ m/s$

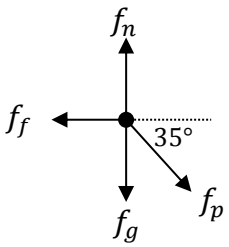
ground
0.20m
$v_f = 3.96m/s$
$a = ?$
$v_i = 0$

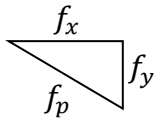
$v_f^2 = v_i^2 + 2ad$
$a = \frac{v_f^2 - v_i^2}{2d}$
$a = \frac{3.96^2 - (0)^2}{2(0.20)} = 39.2m/s^2$

$f_l - f_g = ma$
$f_l = ma + f_g$
$f_l = (70)(39.2) + (70)(9.8)$
$f_l = 3430N = 3400N$

16. A student pushes a 25 kg lawn mower with a force of 150 N. The Handle makes an angle of 35° to the horizontal.

a. Find the vertical and horizontal components of the applied force.





$sin35 = \frac{f_y}{150}$
$f_y = (\sin 35)(150)$
$f_y = 86.04\ N = 86N$

$cos35 = \frac{f_x}{150}$
$f_x = (\cos 35)(150)$
$f_x = 122.87N = 120N$

b. Calculate the normal force supporting the lawn mower while it is being pushed.

$+f_n = ?$
$-f_g = mg$
$= (25)(9.8)$
$= 245\ N$
$-f_y = 86.04N$

$f_n - f_y - f_g = ma$
$f_n - f_y - f_g = 0$
$f_n = f_g + f_y$
$f_n = 245 + 86$
$f_n = 331\ N = 330N$

c. Calculate the net force propelling the mower if a frictional force of 85 N exists.

$+f_x = 122.87N$
$-f_f = 85N$
$f_{net} = f_x - f_f$
$f_{net} = 122.87 - 85$
$f_{net} = 38N$

d. Calculate the horizontal acceleration of the lawn mower.

$f_{net} = ma$
$38 = (25)a$
$a = \frac{38}{25} = 1.5m/s^2$

e. What is the coefficient of friction between the mower and the grass?

$f_f = \mu f_n$
$\mu = \frac{f_f}{f_n}$

$\mu = \frac{85}{331}$
$\mu = 0.26$

Unit 3- Momentum & Energy

Short Answer

1. Define momentum qualitatively and quantitatively.

Momentum, a vector, is the product of an objects mass and velocity.(mass in motion)

$$\vec{p} = m\vec{v}$$

2. State the impulse-momentum theorem and give one example of its use.

The impulse-momentum theorem states that the impulse is a change in momentum

$$\vec{F}\Delta t = m\overrightarrow{v_f} - m\overrightarrow{v_i}$$

3. If you throw a ball against a wall, which of the three impulses is the greatest: throw, bounce, or catch?

The greatest impulse would occur when the ball hits the wall because there would be a change in direction creating a greater velocity change, therefore a greater impulse.

4. How is it possible for an object to obtain a larger impulse from a smaller force than from a larger force?

$\vec{J} = \vec{F}\Delta t$, the force would just have to act for a grater time interval.

5. You drop a dish from the table. Explain whether the impulse will be less if the dish lands on a carpet instead of a bare floor.
   The impulse will be the same assuming that the dish is brought to a stop. The carpet increases the impact time, decreasing the impact force on the dish so that the dish does not break. If the dish hits the bare floor, the impact time is small, but the force is large enough to cause the dish to break.
6. After pushing against a brick wall for a long time, you are feeling extremely tired, but you have not done any work on the wall. Explain.
   In order for work to be done the force needs to cause the displacement. If there is no displacement no work is done.

7. By what factor does the kinetic energy of an object change if its speed is doubled?
   $E_k = \frac{1}{2}mv^2$
   $E_k = \frac{1}{2}m(2v)^2$ E_k will increase by a factor of 4
   $E_k = \frac{1}{2}m4v^2$
   $E_k = 4\left(\frac{1}{2}mv^2\right)$

8. A baseball and a car can have the same kinetic energy. If this is true, what must be different about them? In this situation, how would the motion of each object compare?
   In order for two objects with different masses to have the same kinetic energy they must have different velocities. The object with a smaller mass must have a larger velocity.

Problems

1. What is the mass of a car that is travelling with a velocity of 28 m/s[W] and a momentum of 4.2×10^4 kgm/s[W]? [Ans:1500kg]

   $v = 28\,m/s[w]$
   $p = 4.2 \times 10^4 \frac{kgm}{s}$ [w]
   $m = ?$

   $\vec{p} = m\vec{v}$
   $m = \frac{p}{v}$
   $m = \frac{4.2 \times 10^4}{28}$
   $m = 1500\,kg$

2. The momentum of a 55.0 kg in-line skater is 66.0 kgm/s [S]. What is his velocity? [Ans:1.20 m/s [S]]

   $p = 66.0 \frac{kgm}{s}$ [S]
   $m = 55.0\,kg$
   $v = ?$

   $\vec{p} = m\vec{v}$
   $\vec{v} = \frac{\vec{p}}{m}$
   $\vec{v} = \frac{66.0}{55}$
   $\vec{v} = 1.20 \frac{m}{s}\ [S]$

3. How fast would a 5.0×10^{-3}kg golf ball have to travel to have the same momentum as a 5.0 kg bowling ball that is rolling at 6.0 m/s? [Ans:6000 m/s]

   $m_1 = 5.0 \times 10^{-3} kg$
   $m_2 = 5.0\,kg$
   $v_2 = 6.0 \frac{m}{s}$
   $v_1 = ?$

   $\vec{p} = m\vec{v}$
   $m_1\vec{v}_1 = m_2\vec{v}_2$
   $(5.0 \times 10^{-3})(\vec{v}_1) = (5.0)(6.0)$
   $\vec{v}_1 = 6000$ m/s forward

4. Calculate the impulse for the following interactions.
   a. A person knocks at the door with an average force of 9.1 N [E] over a time interval of 2.5 x 10^{-3}s. [Ans:0.023 N s [E]]

$F = 9.1\ N[E]$
$t = 2.5 \times 10^{-3} s$
$\vec{J} =$

$\vec{J} = \vec{F}\Delta t$
$\vec{J} = (9.1)(2.5 \times 10^{-3})$
$\vec{J} = 0.023\ Ns\ [E]$

   b. A wooden mallet strikes a large iron gong with an average force of 4.2 N[S] over a time interval of 8.6 x 10^{-3}s. [Ans:0.036 N s[S]]

$F = 4.2\ N[S]$
$t = 8.6 \times 10^{-3} s$
$\vec{J} =?$

$\vec{J} = \vec{F}\Delta t$
$\vec{J} = (4.2)(8.6 \times 10^{-3})$
$\vec{J} = 0.036\ Ns\ [S]$

5. A volleyball player spikes the ball with an impulse of 8.8 Ns over a duration of 2.3 x 10^{-3}s. What is the average applied force? [Ans:3800N]

$t = 2.3 \times 10^{-3} s$
$\vec{J} = 8.8\ Ns$
$F =?$

$\frac{\vec{J}}{\Delta t} = \vec{F}$
$\vec{F} = \frac{8.8}{2.3 \times 10^{-3}}$
$\vec{F} = 3800\ N$

6. a. What is the impulse of a 0.300 kg hockey puck slap shot that strikes the goal post at a velocity of 44 m/s [N] and rebounds straight back with a velocity of 9.2 m/s [S]? [Ans:16 N s]

$m = 0.300kg$
$v_i = 44\frac{m}{s}[N]$
$v_f = 9.2\frac{m}{s}[S]$

$\vec{J} = \Delta\vec{p}$
$\vec{J} = m\vec{v}_f - m\vec{v}_i$
$\vec{J} = (0.300)(-9.2) - (0.300)(44)$
$\vec{J} = -15.96\ Ns = 16\ Ns\ [S]$

   b. If the average force of the interaction was -2.5 x 10^3N, what was the duration of the interaction? [Ans:0.0064 s]

$F = -2.5 \times 10^3 N$
$t =?$
$\vec{J} = \Delta\vec{p}$
$\vec{F}\Delta t = \Delta\vec{p}$

$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$
$\vec{F} = \frac{-15.96}{-2.5 \times 10^3}$
$\vec{F} = 0.006384s = 0.0064\ s$

7. A 2.5 kg curling stone is moving down the ice at 3.5 m/s [W]. What force would be needed to stop the stone in a time of 3.5 x 10^{-4}s? [Ans:25000 N[E]]

$m = 2.5\ kg$
$v_i = 3.5\frac{m}{s}[W]$
$\Delta t = 3.5 \times 10^{-4} s$
$v_f = 0\frac{m}{s}$
$\vec{F} =?$

$\vec{F}\Delta t = m\vec{v}_f - m\vec{v}_i$
$\vec{F} = \frac{m\vec{v}_f - m\vec{v}_i}{\Delta t}$
$\vec{F} = \frac{(2.5)(0) - (2.5)(3.5)}{3.5 \times 10^{-4}}$
$\vec{F} = 25000\ N\ [E]$

8. A 48.0 kg skateboarder kicks his 7.0 kg board ahead with a velocity of 2.6 m/s [E]. If he runs with a velocity of 3.2 m/s [E] and jumps onto the skateboard, what is the velocity of the skateboard and the skateboarder immediately after he jumps on the board? [Ans:3.1 m/s [E]]

$m_s = 48.0\ kg$
$m_b = 7.0\ kg$
$v_{bi} = 2.6\frac{m}{s}[E]$
$v_{si} = 3.2\frac{m}{s}[E]$
$v_f = ?$

$m_s v_{si} + m_b v_{bi} = v_f(m_s{+}m_b)$
$(48.0)(3.2) + (7.0)(2.6) = v_f(48.0 + 7.0)$
$\frac{(48.0)(3.2) + (7.0)(2.6)}{55} = \frac{v_f(55)}{55}$
$v_f = 3.12\frac{m}{s} = 3.1\frac{m}{s}$

9. Astrid, who has a mass of 37.0 kg, steps off a stationary 8.0 kg toboggan onto the snow. If her forward velocity is 0.50 m/s, what is the recoil velocity of the toboggan?(assume that friction is negligible.) [Ans:-2.31 m/s]

$m_a = 37.0\ kg$
$m_t = 8.0\ kg$
$v_{ai} = 0\frac{m}{s}$
$v_{ti} = 0\frac{m}{s}$

$v_{af} = 0.5\frac{m}{s}$
$v_{tf} = ?$

$v_i(m_a + m_t) = m_a v_{af} + m_t v_{tf}$
$0(37.0 + 8.0) = (37.0)(0.5) + (8.0)(v_{tf})$
$0 = 18.5 + 8.0v_{tf}$
$\frac{-18.5}{8.0} = \frac{8.0v_{tf}}{8.0}$
$v_{tf} = -2.31\frac{m}{s}$

10. A 60.0 t (1 t = 1000 kg)submarine, initially travelling forward at 1.5 m/s, fires a 5.30 x 10^2 kg torpedo straight ahead with a velocity of 21 m/s in relation to the submarine. What is the velocity of the submarine immediately after it fires the torpedo? [Ans:1.3 m/s]

$m_s = 60.0\ t = 60\ 000kg$
$m_t = 5.0 \times 10^2\ kg$
$v_{si} = 1.5\frac{m}{s}$
$v_{ti} = 1.5\frac{m}{s}$
$v_{tf} = 21 + 1.5\frac{m}{s} = 22.5\frac{m}{s}$
$v_{sf} = ?$

$v_i(m_s + m_t) = m_s v_{sf} + m_t v_{tf}$
$1.5(60\ 000 + 500) = (60\ 000)(v_{sf}) + (500)(22.5)$
$90750 = (60\ 000)(v_{sf}) + 11250$
$\frac{90750 - 11250}{60\ 000} = \frac{60\ 000v_{sf}}{60\ 000}$
$v_{sf} = 1.325\frac{m}{s} = 1.3\frac{m}{s}$

11. Suppose that a 75.0 kg goalkeeper catches a 0.40kg ball that is moving at 32 m/s. With what forward velocity must the goalkeeper jump when she catches the ball so that the goalkeeper and the ball have a horizontal velocity of zero? [Ans:0.17m/s]

$m_g = 75.0\ kg$
$m_b = 0.40kg$
$v_{bi} = -32\frac{m}{s}$
$v_{gi} = ?$
$v_f = 0$

$m_g v_{gi} + m_b v_{bi} = v_f(m_g{+}m_b)$
$(75.0)(v_{gi}) + (0.40)(-32) = 0$
$\frac{(75.0)(v_{gi})}{75.0} = \frac{12.8}{75.0}$
$v_{gi} = 0.171\frac{m}{s} = 0.17\frac{m}{s}forward$

12. A toddler pushes a chair at a constant speed with a force of 25.0 N for a distance of 2.5 m. How much work is the child doing on the chair?[Ans:63J]

$F_p = 25.0\ N$
$d = 2.5\ m$

$w = Fd\cos\theta$
$w = (25)(2.5)(1)$
$w = 63J$

13. A businesswoman is applying a force of 12.0 N [upwards] to carry her briefcase for a horizontal distance of 200.0 m. How much work is she doing on the briefcase? [Ans: 0.00N]

No work is done. A vertical force cannot cause a horizontal displacement.

14. 4050 J of work was done on a pile of snow to move it 3.4 m. What force must have been applied by the snow plow to do this work? [Ans: 1200N]

$w = 4050\ J$
$d = 3.4\ m$
$F = ?$

$w = Fd\cos\theta$
$\frac{4050}{3.4} = \frac{F(3.4)(1)}{3.4}$
$F = 1191.176\ N = 1200\ N$

15. A women pushes a shopping cart with a force of 75 N at a constant speed ot 0.75 m/s for an hour around the grocery store. How much work does she do on the cart? [Ans: 200 000 J]

$F = 75\ N$
$v = 0.75\frac{m}{s}$
$t = 1h = 3600s$

$v = \frac{d}{t}$
$d = vt$
$d = (0.75)(3600)$
$d = 2700m$

$w = Fd\cos\theta$
$w = (75)(2700)(1)$
$w = 200\ 000J$

16. The school caretaker is applying a 200 N force 45° to the horizontal to push a lawn mower a horizontal distance of 20.0 m. How much work does he do on the lawn mower, assuming no friction? [Ans:3000J]

$F_p = 200\ N$
$\theta = 45°$
$d = 20.0\ m$

$w = Fd\cos\theta$
$w = (200)(20)(\cos 45°)$
$w = 2828.43\ J = 3000J$

17. If a hair dryer does 3000.0 J of work to heat the air every 2 seconds, what is its power? [Ans: 2000 W]

$w = 3\ 000.0\ J$
$t = 2s$
$P = ?$

$P = \frac{W}{t}$
$P = \frac{3\ 000}{2}$
$P = 1500\ W = 2\ 000W$

18. How long would it take a 1.00 kW electric motor on a conveyor belt to do 750 J of work? [Ans: 0.75 s]

$P = 1.00kW = 1\ 000W$
$w = 750\ J$
$t = ?$
$P = \frac{W}{t}$

$t = \frac{W}{P}$
$t = \frac{750}{1000}$
$t = 0.75\ s$

19. What is the kinetic energy of a 60.0 g tennis ball that is travelling at

a. 10.0 m/s? [Ans:3.00J]

$m = 60.0\ g = 0.06kg$

$v = 10.0\frac{m}{s}$

$E_k = ?$

$E_k = \frac{1}{2}mv^2$

$E_k = \frac{1}{2}(0.06)(10.0)^2$

$E_k = 3.00\ J$

b. 25.0 m/s? [Ans:18.8J]

$m = 60.0\ g = 0.06kg$

$v = 25.0\frac{m}{s}$

$E_k = ?$

$E_k = \frac{1}{2}mv^2$

$E_k = \frac{1}{2}(0.06)(25.0)^2$

$E_k = 18.8\ J$

20. What is the mass of an object that is travelling at 10.0 m/s with kinetic energy of 370 J? [Ans: 7.4kg]

$m = ?$

$v = 10.0\frac{m}{s}$

$E_k = 370\ J$

$E_k = \frac{1}{2}mv^2$

$370 = \frac{1}{2}m(10.0)^2$

$\frac{(370)(2)}{100} = m$

$m = 7.4\ kg$

21. How much work is done by an Olympic tri-athlete who accelerates herself on her bicycle (a combined mass of 105 kg) from 5.0 m/s to 10.0 m/s. Assume she is biking on a level road? [Ans:3900J]

$m = 105\ kg$

$v_i = 5.0\frac{m}{s}$

$v_f = 10.0\frac{m}{s}$

$w = \Delta E_k + \Delta E_p$

$No\ change\ in\ heigh\ \ \therefore no\ E_p$

$w = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$w = \frac{1}{2}(105)(10.0)^2 - \frac{1}{2}(105)(5.0)^2$

$w = 3937.5\ J = 3900\ J$

22. How much gravitational potential energy would a 275.0 g book have if it was placed on a shelf

a. 2.60m high[Ans:7.01J]

$m = 275.0g = 0.275kg$

$h = 2.60\ m$

$E_p = ?$

$E_p = mgh$

$E_p = (0.275)(9.8)(2.60)$

$E_p = 7.01J$

b. 1.80 m high[Ans:4.85J]

$m = 275.0g = 0.275kg$

$h = 1.80\ m$

$E_p = ?$

$E_p = mgh$

$E_p = (0.275)(9.8)(1.80)$

$E_p = 4.85J$

c. 0.30 m high[Ans:0.81J]

$m = 275.0g = 0.275kg$

$h = 0.30\ m$

$E_p = ?$

$E_p = mgh$

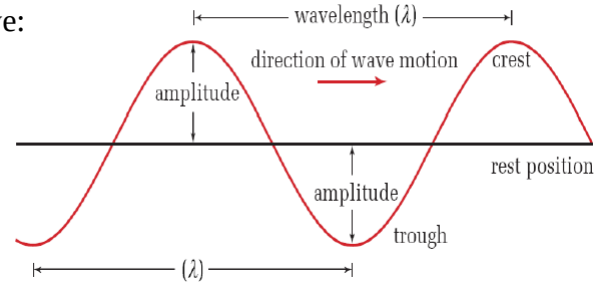
$E_p = (0.275)(9.8)(0.30)$

$E_p = 0.809\ J = 0.81\ J$

Unit 4 Waves

Short Answer

1. What is the primary difference between a mechanical wave and an electromagnetic wave?
   The primary difference between a mechanical wave and an electromagnetic wave is that a mechanical wave requires a medium.
2. What is the difference between a transverse wave and a longitudinal wave?
   A transverse wave the vibrations are perpendicular to the direction of motion. A longitudinal wave the vibrations are parallel to the direction of motion
3. Label the following wave:
   a. Crest
   b. Trough
   c. Amplitude
   d. Wavelength



4. If you want to increase the wavelength of waves in a rope, should you shake it at a higher or lower frequency?
   $v = f\lambda$
   $\lambda = \frac{v}{f}$ Therefore if you want to increase the wavelength you have to decrease or lower the frequency.

5. Rhonda sends a pulse along a rope. How does the position of a point on the rope, before the pulse comes, compare to the position after the pulse has passes?
   The position before the pulse and after the pulse should be the same.

6. What is the difference between wave frequency and wave velocity?
   Wave frequency is how many times a wave passes a fixed point in a second and depends on the vibration of the source, while velocity is how fast the wave is moving and depends solely on the medium.

7. Suppose you produced a transverse wave by shaking one end of a spring back and forth, how does the frequency of your hand compare to the frequency of the wave?
   The frequency of the wave and that of your hand would be the same.
8. Waves are sent along a spring of fixed length.
   a. Can the speed of the wave in the spring change? Explain.
      No the speed of the wave cannot change. The speed of the wave depends only on the medium.

   b. Can the frequency of a wave in the spring be changed? Explain.
      Yes the frequency of the wave can change it depends only on the frequency of the vibrating source.
9. What is the amplitude of a wave and what does it represent?
   The amplitude of the wave is the height of the wave form the rest position to a crest or a trough. Amplitude represent the amount of energy in a wave; greater amplitude more energy.

10. What is the relationship between the amplitude of a wave and the energy carried?
    The relationship between amplitude and energy is proportional. The greater the energy carried the greater the amplitude.

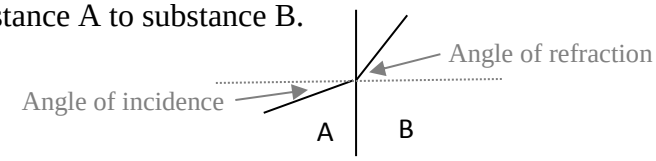
11. Sound doesn't travel through a vacuum; how to we know that light does?
    We can see the stars and space is a vacuum therefore light must travel through a vacuum.

12. What is meant by the normal to a surface?
    A normal line is a line drawn perpendicular to the surface.
13. How does regular reflection differ from diffuse reflection?
    With regular reflection rays go in and are reflected parallel. With diffuse reflection wave go in parallel but are reflected in a diffuse pattern (in all different direction).

14. A ray of light strikes a mirror at an angle of 53° to the normal.
    a. What is the angle of reflections?
    The angle of reflection would also be 53˚.

    b. What is the angle between the incident ray and the reflected ray?
    The angle between the incident ray and the reflected ray would be 106˚ (53 +53)

15. Draw a normal and label the angle of incidence and the angle of refraction if the light went from substance A to substance B.



16. Compare the angle of incidence with the angle of refraction when a light ray passes from air into glass at a non-zero angle.
    Less to more it bends towards- in this case the angle in incidence would be greater than the angle of refraction.

17. Compare the angle of incidence with the angle of refraction when a light ray leaves glass and enters air at a non-zero angle.
    More to less it bends away- in the case the angle of incidence would less than the angle of refraction.

18. What is the "critical angle" of incidence?
    A critical angle of incidence is the angle and which if your incidence angle is greater than your critical angle you will have total internal reflection. You can only have a critical angle if light is going from a medium of greater optical density to one of less.
19. What happens to a ray of light with an angle of incidence greater than the critical angle?
    Total internal reflection.

Problems

20. The sears building in Chicago sways back and forth with a frequency of about 0.10 Hz. What is the period of vibration?
    $f = 0.10\ Hz$
    $T = ?$
    $$T = \frac{1}{f} = \frac{1}{0.10} = 10.\ s$$
21. An ocean wave has a length of 10.0 m. A wave passes a fixed location every 2.0s. What is the speed to the wave?
    $\lambda = 10.0\ m$
    $T = 2.0s$
    $v = ?$
    $$v = \frac{\lambda}{T} = \frac{10.0}{2.0} = 5.0\ m/s$$
22. The frequency of yellow light is 5.0 x 10^{14} Hz. Find its wavelength.
    $f = 5.0 \times 10^{14} Hz$
    $v = 3.0 \times 10^{8} m/s$
    $v = f\lambda$
    $$\lambda = \frac{v}{f} = \frac{3.0 \times 10^{8}}{5.0 \times 10^{14}} = 6.0 \times 10^{-7} m$$
23. A sound wave of wavelength 0.70 m and velocity 330m/s is produced for 0.50s.
    $\lambda = 0.70\ m$ $\quad v = 330\frac{m}{s}$ $\quad t = 0.50s$

    a. What is the frequency of the wave?
    $v = f\lambda$
    $f = \frac{330}{0.70} = 471.4\ Hz = 470\ Hz$

    b. How many complete waves are emitted in this time interval?
    $T = \frac{1}{f} = \frac{1}{471.4} = 0.00212\ s$
    $\#\ of\ waves\ = \frac{0.50}{0.00212} = 235.7 = 240$

    c. After 0.50 s, how far is the front wave from the source of the sound?

$d = vt$
$d = (330)(0.50) = 165\ m = 170m$

24. Find the frequency of a sound wave moving in air at room temperature with a wavelength of 0.667m.

$\lambda = 0.667\ m$
$v = 331 + 0.59T$
$v = 331 + 0.59(20)$
$v = 342.8\ m/s$

$v = f\lambda$
$f = \frac{342.8}{0.667} = 513.9\ Hz = 514\ Hz$

25. Find the speed of sound if the temperature is:

a. 10.0 °C
$v = 331 + 0.59T$
$v = 331 + 0.59(10)$
$v = 337m/s$

b. -15.0°C
$v = 331 + 0.59T$
$v = 331 + 0.59(-15)$
$v = 322m/s$

c. 25.0°C
$v = 331 + 0.59T$
$v = 331 + 0.59(25)$
$v = 346m/s$

26. The sun is 1.5 x 10^8 km from earth. How long does it take for its light to reach us?

$d = 1.5 \times 10^8 km = 1.5 \times 10^{11} m$
$v = 3.0 \times 10^8 m/s$

$t = \frac{d}{v} = \frac{1.5 \times 10^{11}}{3.0 \times 10^8} = 500s$

27. Water waves in a lake travel 4.4 m in 1.8 s. the period of oscillation is 1.2 s.

$d = 4.4\ m$ $t = 1.8\ s$ $T = 1.2\ s$

a. What is the speed of the water wave?

$v = \frac{d}{t} = \frac{4.4}{1.8} = 2.4\ m/s$

b. What is their wavelength?

$v = \frac{\lambda}{T}$

$\lambda = (2.44)(1.2)$
$\lambda = 2.93\ m = 2.9m$

28. Sound with a frequency of 442 Hz travels through steel. A wavelength of 11.66 m is measured. Find the speed of sound in steel.

$f = 442\ Hz$
$\lambda = 11.66\ m$

$v = f\lambda$
$v = (442)(11.66)$
$= 5153.72 = 5150\ m/s$

29. Jane is on a train that is traveling at 95 km/h. The train passes a factory whose whistle is lowing at 288 Hz. What frequency does Jane hear as the train approaches the factory (assume air temp of 20˚)?

$v_o = \frac{95km}{h} = 26.4m/s$
$f = 288Hz$
$v = 342.8m/s$
$v_s = 0$
$f' = ?$

$f' = f\left(\frac{v + v_o}{v - v_s}\right)$
$f' = 288\left(\frac{342.8 + 26.4}{342.8 - 0}\right) = 310.17Hz = 310Hz$

30. A train moving away person at 31 m/s blows its 305 Hz horn. What frequency is detected by the person if he is walking in the same direction as the train at 5.0 m/s(assume air temp of 20˚)?

$v_o = 5m/s$
$f = 305Hz$
$v = 342.8m/s$
$v_s = 31m/s$
$f' = ?$

$f' = f\left(\frac{v - v_o}{v + v_s}\right)$
$f' = 305\left(\frac{342.8 - 5}{342.8 + 31}\right) = 275.6Hz = 280Hz$

31. Light in air is incident upon a piece of crown glass (n = 1.52) at an angle of 45.0°. What is the angle of refraction?

$n_i = 1.0003$
$n_r = 1.52$
$\theta_i = 45°$
$\theta_r = ?$
$n_i sin\theta_i = n_r sin\theta_r$
$(1.0003)(sin45) = (1.52)sin\theta_r$

$\frac{(1.0003)(sin45)}{(1.52)} = sin\theta_r$
$sin\theta_r = 0.4653$
$\theta_r = 27.7°$

32. A ray of light is incident upon a diamond at 45.0°. What is the angle of refraction?

$n_i = 1.0003$
$n_r = 2.42$
$\theta_i = 45°$
$\theta_r = ?$
$n_i sin\theta_i = n_r sin\theta_r$
$(1.0003)(sin45) = (2.42)sin\theta_r$
$\frac{(1.0003)(sin45)}{(2.42)} = sin\theta_r$
$sin\theta_r = 0.2923$
$\theta_r = 17.0^{\circ}$

33. A ray of light has an angle of incidence of 30.0° on a block of quartz and an angle of refraction of 20.0°. What is the index of refraction for this block of quartz?

$n_i = 1.0003$
$n_r = ?$
$\theta_i = 30.0°$
$\theta_r = 20.0$
$n_i sin\theta_i = n_r sin\theta_r$
$(1.0003)(sin30) = n_r sin20°$
$\frac{(1.0003)(sin30)}{(sin20)} = n_r$
$n_r = 1.46$

34. A ray of light is incident at an angle of 60.0° upon the surface of a piece of crown glass. What is the angel of refraction?

$n_i = 1.0003$
$n_r = 1.52$
$\theta_i = 60.0°$
$\theta_r = ?$
$n_i sin\theta_i = n_r sin\theta_r$
$(1.0003)(sin60) = (1.52)sin\theta_r$
$\frac{(1.0003)(sin60)}{(1.52)} = sin\theta_r$
$sin\theta_r = 0.5699$
$\theta_r = 34.7^{\circ}$

35. Find the critical angel for diamond.

$n_i = 2.42$
$n_r = 1.0003$
$\theta_i = ?°$
$\theta_r = 90.0°$
$n_i sin\theta_i = n_r sin\theta_r$
$(2.42)(sin\theta_c) = (1.0003)sin90$
$\frac{(1.0003)(sin90)}{(2.42)} = sin\theta_c$
$sin\theta_c = 0.4133$
$\theta_c = 24.4^{\circ}$

36. A block of glass has a critical angle of 45.0° what is its index of refraction?

$n_i = ?$
$n_r = 1.0003$
$\theta_c = 45°$
$\theta_r = 90.0°$
$n_i sin\theta_i = n_r sin\theta_r$
$(n_i)(sin45) = (1.0003)sin90$
$\frac{(1.0003)(sin90)}{(sin45)} = n_i$
$n_i = 1.41$

37. The critical angle for special glass in air is 41.0°. What is the critical angle if the glass is immersed in water?

$n_i = ?$
$n_r = 1.0003$
$\theta_c = 41.0°$
$\theta_r = 90.0°$
$n_i sin\theta_i = n_r sin\theta_r$
$(n_i)(sin45) = (1.0003)sin90$
$\frac{(1.0003)(sin90)}{(sin41)} = n_i$
$n_i = 1.52$

$n_i = 1.52$
$n_r = 1.33$
$\theta_c = ?$
$\theta_r = 90.0°$
$n_i sin\theta_i = n_r sin\theta_r$
$(1.52)(sin\theta_c) = (1.33)sin90$
$\frac{(1.33)(sin90)}{(1.52)} = sin\theta_c$
$sin\theta_c = 0.875$
$\theta_c = 61.0°$