2048 Temperature Homework

Temperature Scale Conversions

1) Convert 72°C to °K. (345K)

$K = °C + 273 \Rightarrow 72 + 273 = \boxed{345\,K}$

2) Convert 94°C to °K. (367K)

3) Convert 79°K to °C. (-194*C)

4) Convert 94°K to °C. (-179*C)

5) Convert 125°K to °C. (-148*C)

6) Convert 72°C to °F. (+161.6*C)

7) Convert 43°C to °F. (+109.4*C)

8) Convert 94°C to °F. (+201.2*C)

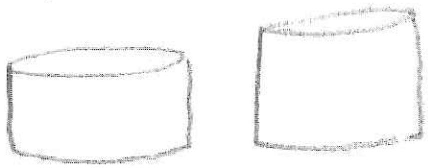
9) Convert 55°F to °C (+12.8*C)

10) Convert 27°F to °C. (-2.8*C)

11) Convert 122°F to °C. (+50*C)

P, V and T changes in a Sample of Ideal Gas

12) A sample of gas is trapped in the cylinder of a syringe. It initially has a pressure of 9Pa, volume of 2m^3 and temperature of 15K. The volume available to the gas can be increased or decreased. The sample of gas can be heated or cooled. What is the gas sample's temperature when its pressure is 27Pa and its volume is 8m^3? (180K)



$P_1 = 9$ Pa $P_f = 27$ Pa
$V_1 = 2\,m^3$ $V_f = 8\,m^3$
$T_1 = 15$ K $T_f = ?$

$PV = nRT \} \frac{PV}{T} = \text{const}$

$$\frac{P_1 V_1}{T_1} = \frac{P_f V_f}{T_f}$$

$$\frac{(9)(2)}{(15)} = \frac{(27)(8)}{T_f}$$

$$T_f = \frac{(27)(8)(15)}{(9)(2)} = \boxed{180K}$$

13) A sample of gas is trapped in the cylinder of a syringe. It initially has a pressure of 15Pa, volume of 4m^3 and temperature of 45K. The volume available to the gas can be increased or decreased. The sample of gas can be heated or cooled. What is the gas sample's pressure when its volume is 6m^3 and its temperature is 80K? (17.8Pa)

14) A sample of gas is trapped in the cylinder of a syringe. It initially has a pressure of 33Pa, volume of $3m^3$ and temperature of 150°C. The volume available to the gas can be increased or decreased. The sample of gas can be heated or cooled. What is the gas sample's volume when its pressure is 99Pa and its temperature is 420°C? ($1.6m^3$ not $2.8\ m^3$)

15) A sample of gas is trapped in the cylinder of a syringe. It initially has a pressure of 82Pa, volume of $5m^3$ and temperature of 62°C. The volume available to the gas can be increased or decreased. The sample of gas can be heated or cooled. What is the gas sample's temperature when its volume is $15m^3$ and its pressure is 41Pa? (502K or 229°C)

16) A sample of gas is trapped in the cylinder of a syringe. It initially has a pressure of 38Pa. The volume available to the gas can be increased or decreased. The sample of gas can be heated or cooled. What is the gas sample's pressure if its volume is doubled and its absolute temperature is halved? (9.5Pa)

Moles of gas molecules, Temperature, Pressure, and Volume

17) A sample of gas has a pressure of 5Pa and a volume of $6m^3$ at 300K. How many moles of gas molecules does it contain? (0.01mole).

$P = 5\,Pa$

$V = 6\,m^3$

$T = 300\,K$

$n = ?\ mole$

$R = 8.3\ J/K\,mol$

$PV = nRT$

$n = \frac{PV}{RT}$

$n = \frac{(5)(6)}{R(300)}$

$n = \frac{0.1}{R}\ moles = \boxed{0.012\ moles}$

18) A sample of gas has a pressure of 23Pa and a volume of $2m^3$ at 160K. How many moles of gas molecules does it contain? (0.04mole).

19) A sample of gas has a pressure of 80Pa and a volume of $5m^3$ at 420°C. How many moles of gas molecules does it contain? (0.07mole not 0.11mole).

20) A sample of gas has a pressure of 6Pa and a volume of $2m^3$ at 40°C. How many moles of gas molecules does it contain? ($4.8x10^{-3}$ mole).

21) A sample of gas has a pressure of 9Pa and a volume of $2cm^3$ at 60K. How many moles of gas molecules does it contain? ($3.61x10^{-8}$mole).

Number of gas molecules, Temperature Pressure and Volume

22) A sample of gas has a pressure of 5Pa and a volume of $6m^3$ at 300K. How many gas molecules does it contain? (7.25×10^{21} molecules).

$P = 5\,Pa$

$V = 6\,m^3$

$T = 300K$

$N = ?$

$k_b = 1.4 \times 10^{-23}\ J/K$

$PV = N k_b T$

$N = \frac{PV}{k_b T} = \frac{(5)(6)}{k_b (300)}$

$N = \frac{0.1}{k_b}$ molecules

$N = \frac{0.1}{1.4 \times 10^{-23}}$

$N = \boxed{7.14 \times 10^{-23} \text{ molecules}}$

23) A sample of gas has a pressure of 23 Pascal and a volume of 2 cubic meters at 160K. How many gas molecules does it contain? (2.08×10^{22} molecules).

24) A sample of gas has a pressure of 16Pa and a volume of $5cm^3$ at 320°C. How many gas molecules does it contain? (9.6×10^{15} molecules).

25) A sample of gas has a pressure of 22Pascal and a volume of 6 cubic millimeters at 77°C. How many gas molecules does it contain? (2.7×10^{13} molecules).

26) Gas sample has a pressure of 6 Pa. It contains X molecules in a volume of Y cubic meters at a temperature of Z Kelvin. What pressure would it have if it had half the volume and twice the absolute temperature? The number of gas molecules is constant. (1.5 Pa)

$N_o = X$ molecules, $N_N = X$ molecules

$P_o = 6\,Pa$ $\quad P_N = ?$

$V = Y\,m^3$ $\quad V_N = 2Y\,m^2$

$T = Z$ Kelvin $\quad T_N = \frac{1}{2}Z$ Kelvin

$PV = N k_b T$

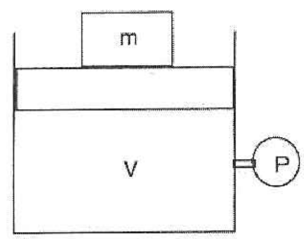
$$\frac{P_N}{P_o} = \frac{\frac{N_N k_b T_N}{V_N}}{\frac{N_o k_b T_o}{V_o}}$$

$$\frac{P_N}{6} = \frac{\frac{(X)\,k_b\,(\frac{1}{2}Z)}{(2Y)}}{\frac{(X)\,k_b\,(1Z)}{(1Y)}} = \frac{\frac{1}{2}}{2} = \frac{1}{4}$$

$P_N = (6)(\frac{1}{4})$

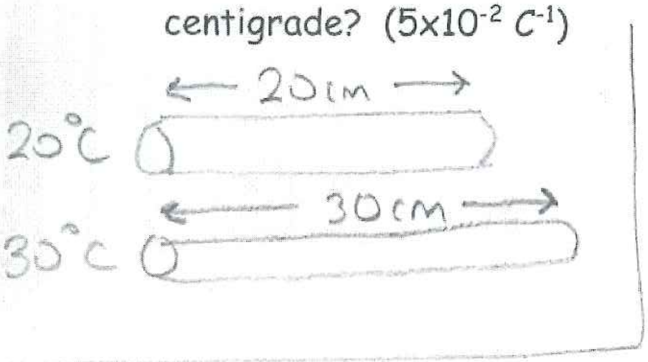
$P_N = \boxed{1.5\ Pa}$

27) A sample of ideal gas is contained in a cylinder that has a cross sectional area of $17mm^2$ and a depth of 15mm. A 40kg mass rests on the lid. The gas temperature is 34*C. How many gal molecules does the cylinder contain? ($1.4x10^{21}$molecules)



Linear Thermal Expansion

28) What is the coefficient of linear thermal expansion of a rod that has a length of 20 cm at 20 degrees centigrade and 30 cm at 30 degrees centigrade? ($5x10^{-2}\ C^{-1}$)



$$\Delta L = L_o \alpha \Delta T$$

$$\alpha = \frac{\Delta L}{L_o \Delta T}$$

$$\alpha = \frac{(0.3 - 0.2)}{0.2(30-20)}$$

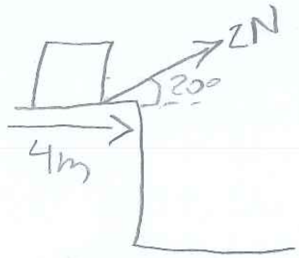
$$\alpha = \frac{0.1}{(0.2)(10)} = \frac{0.1}{2} = 0.05 = \boxed{5\times10^{-2}\ °C^{-1}}$$

29) What is the coefficient of linear thermal expansion of a rod that has a length of 15 cm at 20 degrees centigrade and 20 cm at 35 degrees centigrade? ($0.22\ C^{-1}$)

2048 Work & Energy Homework (answer in () after question)

Work Done By a Constant Force

1) An applied force of 2N directed at 20° elevation above the horizontal acts to move a block 4m along a level table. What is the work done by the applied force? (7.5J)

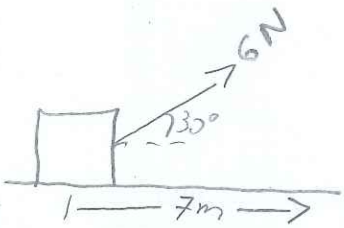


$W = F \cdot d$

$w = (2)(4)\cos 20°$

$\boxed{w = 7.52\ J}$

2) An applied force of 6N directed at 30° elevation above the horizontal acts to move a block 7m along a level table.. What is the work done by the applied force? (36.4J)



$w = F \cdot d \cos\theta$

$W = (6N)(7M)\cos 30°$

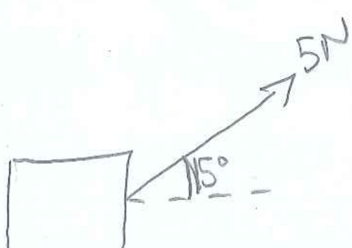
$\boxed{W = 36.4 J}$

3) An applied force of 5N directed at 15° elevation above the horizontal acts to move a block 6m along a level table. What is the work done by the applied force? (29.0J)

$W = Fd\cos\theta$

$w = 5N \cdot 6m \cdot \cos 15°$

$\boxed{w = 29.0\ J}$

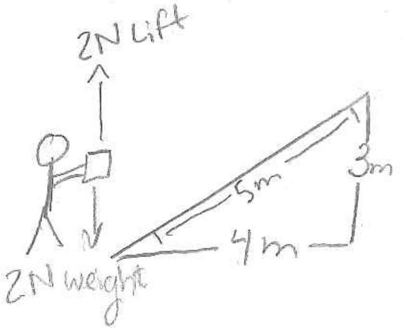


6m

?

$d\cos\theta = 2$? $\tan\theta = \frac{3}{4}$ $\theta = 36.9°$

4) A student carries a 2N bag up a ramp. She moves 4m horizontally and 3m vertically. How much work does her lifting force do during the process? (6J)



$W = F \cdot d\cos\theta$

$F_A = 2N$

Weight $= 2N$

$\theta = 36.9$ or $0°$

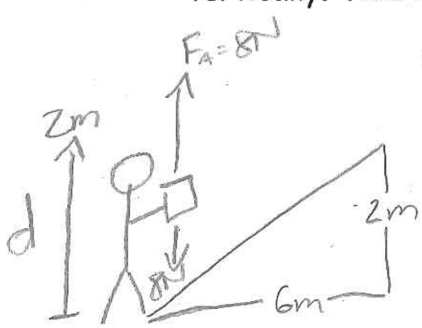
$d = 5m$ or $3m$

$W = 2N \cdot 5m \cdot \cos 36.9$

$W = 2N \cdot 4$

$W = 8J$?

5) A student carries an 8N bag up a ramp. She moves 6m horizontally and 2m vertically. How much work does her lifting force do during the process? (16J)



angle b/w F_A & d is $0°$

$d = 2m$

$\theta = 0°$

$F_A = 8N$

$W = F \cdot d\cos\theta$

$W = F_A \cdot d\cos\theta$

$W = 8N \cdot 2m \cdot \cos 0°$

$W = 16 \cdot 1$

$\boxed{W = 16J}$

6) A student carries a 9kg bag up a ramp. She moves 3m horizontally and 7m vertically. How much work does her lifting force do during the process? (630J)

Lifting Force $= F_A$

$F_A = 90N$ vertically

distance traveled is Vertical from 0m to 7m @ top of Ramp

$F_A = 90N$

$d = 7m$

$\theta = 0°$

Angle b/w distance & F_A = Same direction

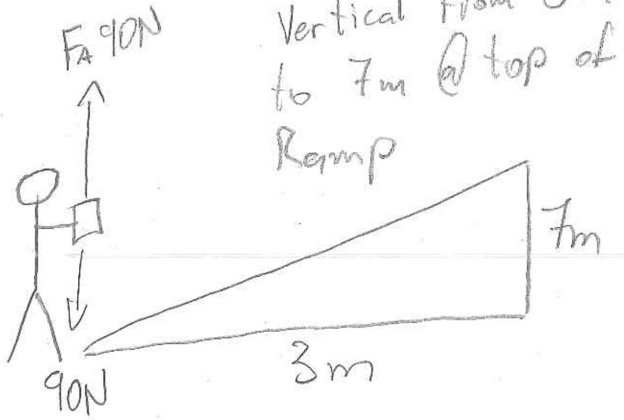
$W = F_A \cdot d\cos\theta$

$W = 90N \cdot 7m\cos 0°$

$W = 90N \cdot 7m(1)$

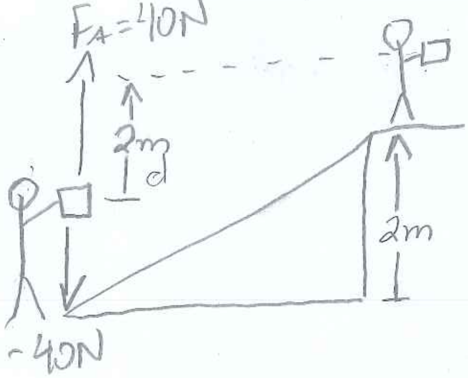
$W = 90N \cdot 7m$

$\boxed{W = 630J}$



2

7) A student carries a 4kg bag up a ramp. She moves 4m horizontally and 2m vertically. How much work does her lifting force do during the process? (80J)



$F_A = 40N$

$d_v = 2m$

$\theta = 0°$

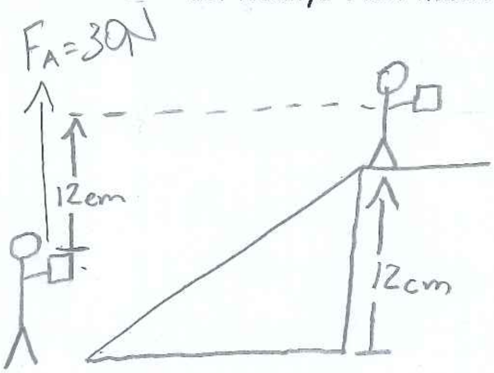
$W = F_A \cdot d \cos\theta$

$W = 40N \cdot 2m \cos 0°$

$W = 40N \cdot 2m(1)$

$\boxed{W = 80J}$

8) A student carries a 3kg bag up a ramp. She moves 65cm horizontally and 12cm vertically. How much work does her lifting force do during the process? (3.6J)



$F_A = 30N$

$d_v = 12 \times 10^{-2} m$

$d_v = 0.12m$

$\theta = 0°$

$W = F_A \cdot d \cdot \cos\theta$

$W = 30N \cdot 0.12m \cdot \cos 0°$

$W = 30N \cdot 0.12m(1)$

$\boxed{W = 3.6J}$

9) A student carries a 4kg bag up a ramp. She moves 122cm horizontally and 156cm vertically. How much work does her lifting force do during the process? (62.4J)

$F_A = 40N$

$d_v = 156 \times 10^{-2} m$

$d_v = 1.56m$

$\theta = 0°$

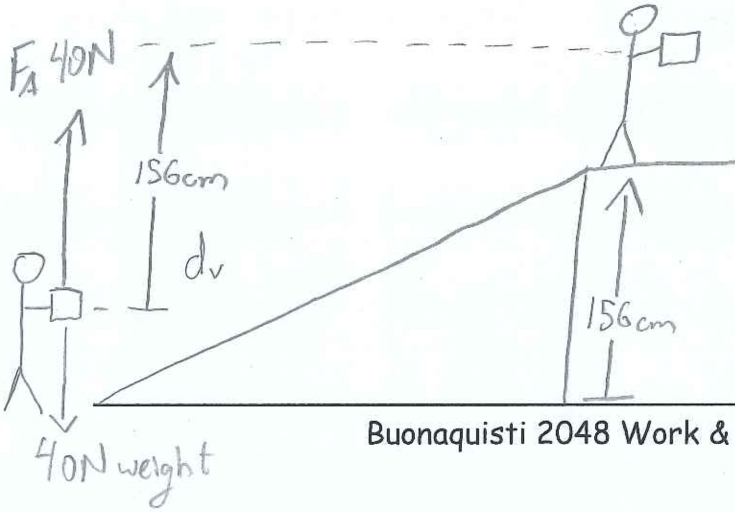
$W = F_A \cdot d \cdot \cos\theta$

$W = 40N \cdot 1.56m \cdot \cos 0°$

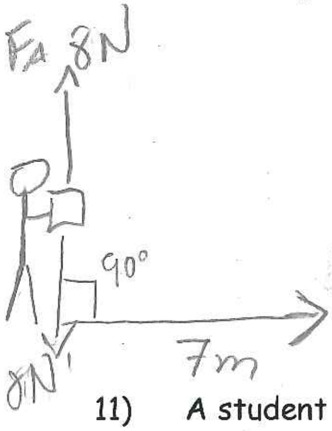
$W = 40N \cdot 1.56m(1)$

$W = 40N \cdot 1.56m$

$\boxed{W = 62.4J}$



10) A student carries an 8N bag 7m along a level path. How much work does her lifting force do during the process? (0J)



$F_A = 8N$

$d = 7m$

θ b/w Force Applied & distance = 90°

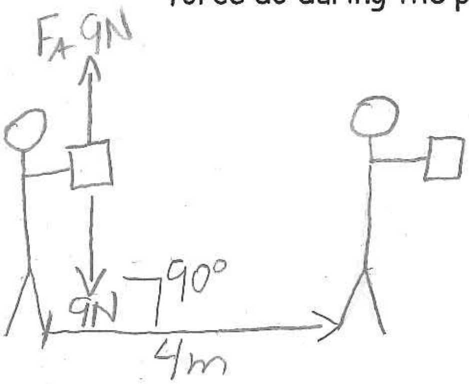
$W = F_A \cdot d \cdot \cos\theta$

$W = 8N \cdot 7m \cdot \cos 90°$

$W = (8)(7)(0)$

$\boxed{W = 0\ J}$

11) A student carries a 9N bag 4m along a level path. How much work does her lifting force do during the process? (0J)



$F_A = 9N$

$d = 4m$

$\theta = 90°$

$W = F_A \cdot d \cdot \cos\theta$

$W = 9N \cdot 4m \cdot \cos 90$

$W = (9)(4)(0)$

$\boxed{W = 0\ J}$

12) What is the work done by my lifting force when I carry a 5 kg mass 3 m across a room? (0J)

$F_A = 50N$

$d = 3m$

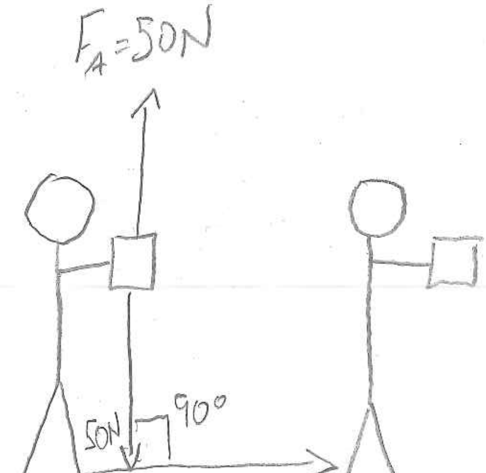
$\theta = 0°$

$W = F_A \cdot d \cdot \cos\theta$

$W = 50N \cdot 3m \cdot \cos 90$

$W = (50N)(3m)(0)$

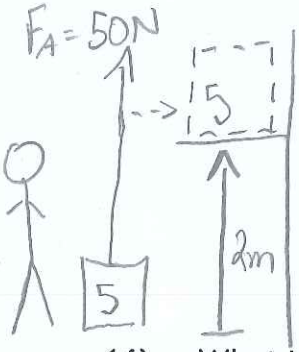
$\boxed{W = 0\ J}$



3m

4

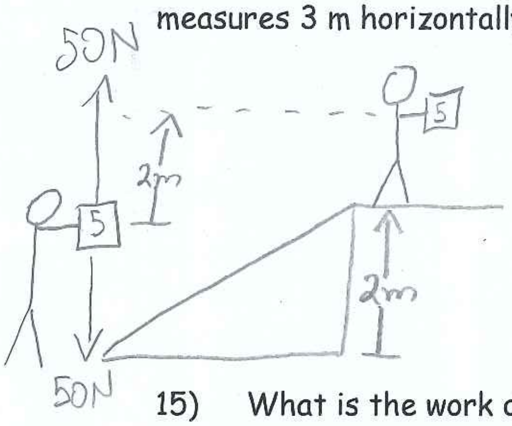
13) What is the work done by my lifting force when I lift a 5 kg mass from the floor to a shelf that is 2 m above the floor? (100J)



$F_A = 50N$
$d = 2m$
θ b/w F_A & $d = 0°$

$W = F_A \cdot d \cdot \cos\theta$
$W = 50N \cdot 2m \cdot \cos 0°$
$W = (50N)(2m)(1)$
$\boxed{W = 100\,J}$

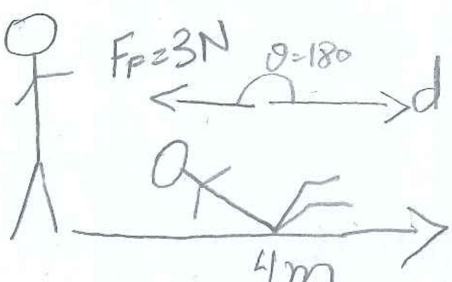
14) What is the work done by my lifting force when I lift a 5 kg mass up a ramp that measures 3 m horizontally and 2 m vertically? (100J)



$F_A = 50N$
$d = 2m$
θ b/w F_A & $d = 0°$

$W = F_A \cdot d \cdot \cos\theta$
$W = 50N \cdot 2m \cdot \cos 0°$
$W = (50N)(2m)(1)$
$\boxed{W = 100\,J}$

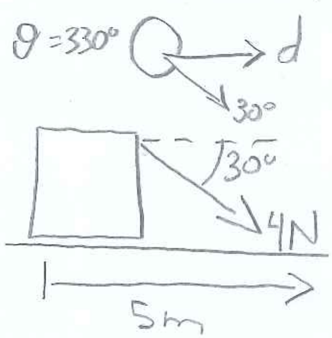
15) What is the work done by my sliding force when I slide into first base? The force of friction is 3 N and the distance that I slide is 4 m. (-12J)



$F_F = -3N$
$\theta = 180°$
$d = 4m$

$W = F \cdot d \cdot \cos\theta$
$W = 3N \cdot 4m \cdot \cos 180$
$W = (3N)(4m)(-1)$
$\boxed{W = -12\,J}$

16) I push a crate with a force of 4 N at an angle of 30 degrees below the horizontal. The crate slides 5 m along the floor. What work did my force do? (17.3J)



$F_A = 4N$
$d = 5m$
$\theta = 330°$

$W = F_A \cdot d \cdot \cos\theta$
$W = 4N \cdot 5m \cdot \cos 330°$
$W = (4N)(5m)(0.866)$
$\boxed{W = 17.3\,J}$

Scalar Product of Two Vectors

Given:
A=(+3i)+(+4j)+(-5k)
B=(+2i)+(-3j)+(-2k)

17) What is A•B? (+4)

$\vec{A}\cdot\vec{B} = (3i)(2i) + (4j)(-3j) + (-5k)(-2k)$

$\vec{A}\cdot\vec{B} = (6) + (-12) + (10)$

$\boxed{\vec{A}\cdot\vec{B} = 4}$

18) What is B•A? (+4)

$\vec{B}\cdot\vec{A} = (2i)(3i) + (-3j)(4j) + (-2k)(-5k)$

$\vec{B}\cdot\vec{A} = (6) + (-12) + (10)$

$\boxed{\vec{B}\cdot\vec{A} = 4}$

19) What is 2(B•A)? (+8)

$2(\vec{B}\cdot\vec{A}) = 2[(2i)(3i) + (-3j)(4j) + (-2k)(-5k)]$

$2(\vec{B}\cdot\vec{A}) = 2[(6) + (-12) + (10)]$

$2(\vec{B}\cdot\vec{A}) = 2(4) = \boxed{8}$

20) What is 2A•B? (+8)

$2\vec{A}\cdot\vec{B} = (2\cdot 3i)(2i) + (2\cdot 4j)(-3j) + (2\cdot -5k)(-2k)$

$2\vec{A}\cdot\vec{B} = (6i)(2i) + (8j)(-3j) + (-10k)(-2k)$

$2\vec{A}\cdot\vec{B} = (12) + (-24) + (20)$

$\boxed{2\vec{A}\cdot\vec{B} = 8}$

Given:
A=(+2i)+(+3j)+(-2k)
B=(+1i)+(-2j)+(-1k)

21) What is A•B? (-2)

$\vec{A}\cdot\vec{B} = (2)(1) + (3)(-2) + (-2)(-1)$

$\vec{A}\cdot\vec{B} = 2 + (-6) + 2$

$\boxed{\vec{A}\cdot\vec{B} = -2}$

Given:
A=(-3i)+(+2j)+(+2k)
B=(+2i)+(-1j)+(-1k)

22) What is A•B? (-10)

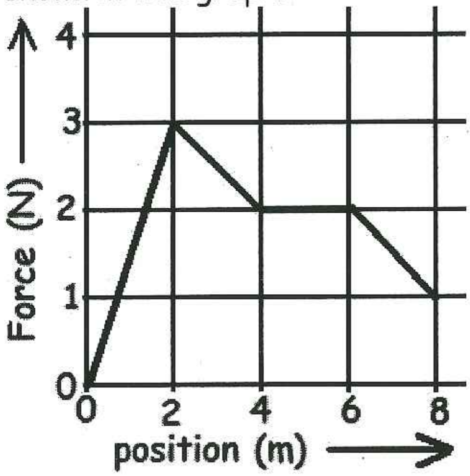
$\vec{A}\cdot\vec{B} = (-3)(2) + (2)(-1) + (2)(-1)$

$\vec{A}\cdot\vec{B} = (-6) + (-2) + (-2)$

$\boxed{\vec{A}\cdot\vec{B} = -10}$

Work Done By a Varying Force (Graph)

A block is acted on by a force. The magnitude of the force varies with position. The variation is shown in this graph.



23) What is the force acting on the block when it is at 2m? (3N)

$\boxed{F@2m = 3N}$

24) What is the force acting on the block when it is at 3m? (2.5N)

$F@3m = (2+3)\frac{1}{2}$

$\boxed{F@3m = 2.5N}$

? Still F·d

25) How much work does the force perform in moving the block from 0m to 2m? (3J)

$W = F \cdot d$ $\quad$ $W = \int f_x\, dx$ = Area @ 2m

$W = 3N \cdot 2m$ or $\quad W = \frac{1}{2}B \cdot H = \frac{1}{2}(2)(3)$

$W = 6J$ $\quad$ $\boxed{W = 3J}$

26) How much work does the force perform in moving the block from 2m to 4m? (5J)

W = Area under curve b/w 2m-4m

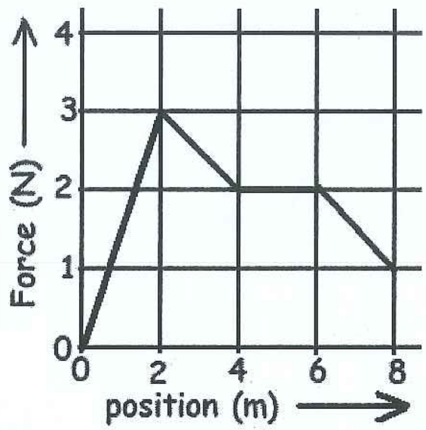
W = Area Trapezium $= \frac{1}{2}(3+2)(2)$

$\boxed{W = 5J}$

8

A block is acted on by a force. The magnitude of the force varies with position. The variation is shown in this graph.

27) How much work does the force perform in moving the block from 4m to 6m? (4J)



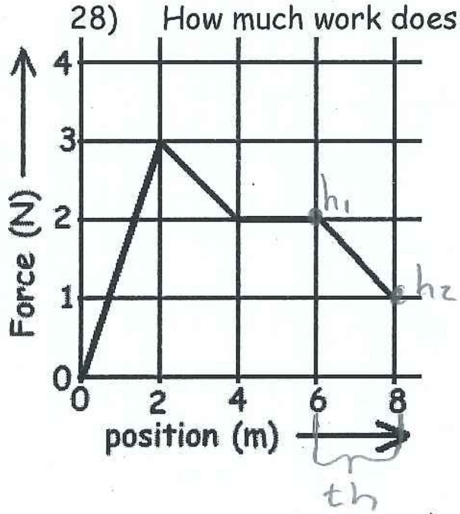
W = Area of rectangle

W = W × L

W = (2)(2)

$\boxed{W = 4J}$

28) How much work does the force perform in moving the block from 6m to 8m? (3J)



W = Area of Trapezium

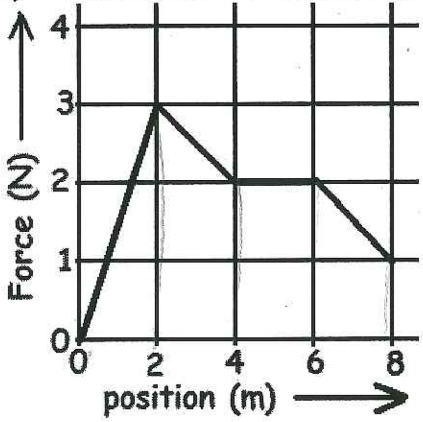
$W = \frac{1}{2}(h_1 + h_2)(th)$

$W = \frac{1}{2}(2+1)(2)$

$\boxed{W = 3J}$

A block is acted on by a force. The magnitude of the force varies with position. The variation is shown in this graph.

29) How much work does the force perform in moving the block from 0m to 8m? (15J)



W = add areas of all geometric shapes

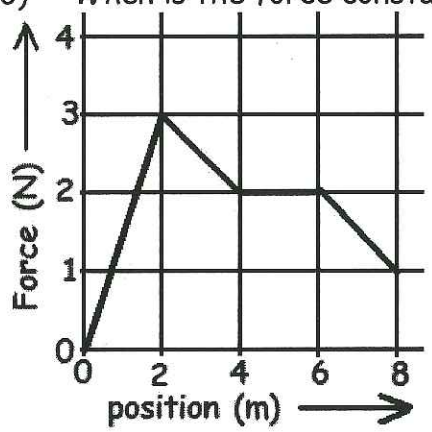
W = Triangle + Trap + Rectangle + Trap

$W = \frac{1}{2}(2)(3) + \frac{1}{2}(3+2)(2) + (2)(2) + \frac{1}{2}(2+1)(2)$

$W = 3 + 5 + 4 + 3$

$\boxed{W = 15\ J}$

30) When is the force constant? (4m to 6m)



between 4m – 6m

Work Done By a Varying Force (Calculus)

A block is acted on by a force that varies as the block is at different positions. The variation is given by, $\mathbf{F} = 3x^2 + 2x - 4$, where F is in Newton and x is in meters.

31) How much work is performed by the force in moving the block from x=0m to x=2m. (4J)

$F = 3x^2 + 2x - 4$

$W = \int_0^2 F_x dx = \int_0^2 3x^2 + 2x - 4 dx$

$W = \left[x^3 + x^2 - 4x\right]\Big|_0^2 = (2^3 + 2^2 - 4 \cdot 2) - 0$

$\boxed{W = 4J}$

32) How much work is performed by the force in moving the block from x=4m to x=6m? (164J)

$W = \int_4^6 F_x dx = \int_4^6 3x^2 + 2x - 4 dx$

$W = \left[x^3 + x^2 - 4x\right]\Big|_4^6 = \left[6^3 + 6^2 - 4 \cdot 6\right] - \left[4^3 + 4^2 - 4(4)\right]$

$W = 228 - 64$

$\boxed{W = 164J}$

A block is acted on by a force that varies as the block is at different positions. The variation is given by, $\mathbf{F} = 6x^2 - 4x + 5$, where F is in Newton and x is in meters.

33) How much work is performed by the force in moving the block from x=0m to x=2m. (18J)

$$W = \int_0^2 6x^2 - 4x + 5\,dx = \left[2x^3 - 2x^2 + 5x\right]\Big|_0^2$$

$$W = \left[2(2^3) - 2(2^2) + 5(2)\right]$$

$$\boxed{W = 18\text{ J}}$$

34) How much work is performed by the force in moving the block from x=4m to x=6m? (274J)

$$W = \int_4^6 6x^2 - 4x + 5\,dx = \left[2x^3 - 2x^2 + 5x\right]\Big|_4^6$$

$$W = \left[2(6)^3 - 2(6)^2 + 5(6)\right] - \left[2(4)^3 - 2(4)^2 + 5(4)\right]$$

$$W = 390 - 116$$

$$\boxed{W = 274\text{ J}}$$

Kinetic Energy

35) A 4kg block has a velocity of 2m/s. What is its kinetic energy? (8J)

$m = 4kg$

$V = 2\frac{m}{s}$

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

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

$KE = \frac{1}{2}(4)(2)^2$

$KE = \frac{1}{2}(4)(4)$

$KE = 2(4)$

$\boxed{KE = 8J}$

36) An 8kg block has a velocity of 3m/s. What is its kinetic energy? (36J)

$m = 8kg$

$V = 3\frac{m}{s}$

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

$KE = \frac{1}{2}(8)(3)^2$

$KE = 4(9)$

$\boxed{KE = 36J}$

37) A 3kg block has a velocity of 4m/s. What is its kinetic energy? (24J)

$m = 3kg$

$V = 4\frac{m}{s}$

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

$KE = \frac{1}{2}(3)(4)^2$

$KE = \frac{1}{2}(3)(16)$

$KE = (3)(8)$

$\boxed{KE = 24J}$

38) What is the kinetic energy of a 4 kg mass traveling at 5 m/s? (50J)

$m = 4kg$

$V = 5\frac{m}{s}$

~~KE~~

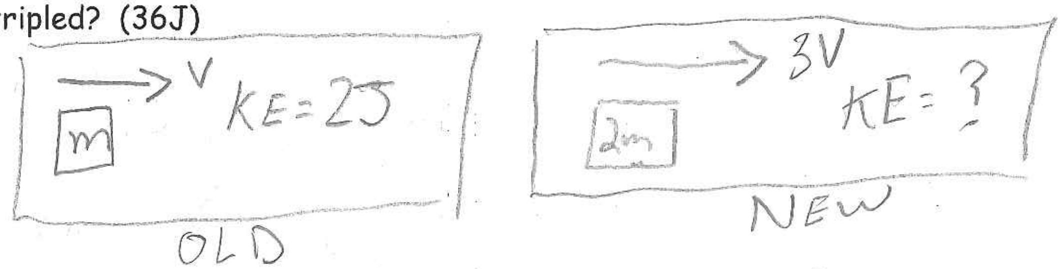
$KE = \frac{1}{2}mv^2$

$KE = \frac{1}{2}(4)(5)^2$

$KE = 2(25)$

$\boxed{KE = 50J}$

39) A model car has a certain mass and a specific velocity, so it has a 2J of kinetic energy. What would be its kinetic energy if its mass was doubled and its velocity was tripled? (36J)



Ratio method =

$$\frac{KE_{new}}{KE_{old}} = \frac{\frac{1}{2} m_{new} \cdot (V_{new})^2}{\frac{1}{2} m_{old} \cdot (V_{old})^2}$$

$$\frac{KE_{new}}{(2)} = \frac{\cancel{\frac{1}{2}}(2\cancel{m}) \cdot (3\cancel{v})^2}{\cancel{\frac{1}{2}}(1\cancel{m}) \cdot (1\cancel{v})^2}$$

$$\frac{KE_{new}}{2} = \frac{(2)(3)^2}{(1)(1)^2}$$

$$\frac{KE_{new}}{2} = 18$$

$$KE_{new} = (18)(2)$$

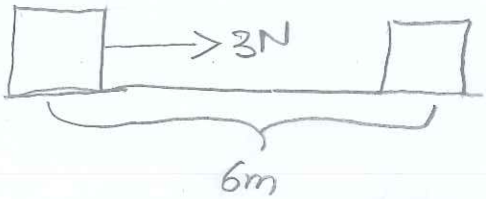
$$\boxed{KE_{new} = 36\ J}$$

14

Work Energy Theorem

A horizontal 3N force accelerates a block from rest through a distance of 6m along a smooth level surface.

40) What is the kinetic energy of the block at the end of this journey? (18J)



$W = F \cdot d$

$F \cdot d = KE_F - KE_i \longrightarrow (3)(6) = KE_F - \frac{1}{2}m(0)^2$

$V_i = 0\frac{m}{s}$

$18 = KE_F - 0$

$\boxed{KE = 18J}$

$W = F \cdot d$

$W = m\underbrace{ad}$

$V_F^2 = V_i^2 + 2ad$

$ad = \frac{V_F^2 - V_i^2}{2}$

$\rightarrow W = m \cdot \left(\frac{V_F^2 - V_i^2}{2}\right)$

$W = \frac{1}{2}mV_F^2 - \frac{1}{2}mV_i^2$

$W = KE_F - KE_i$

41) What is the kinetic energy of the block after it is moved through 3m? (9J)

$W = \Delta KE$

$W = KE_F - KE_i$

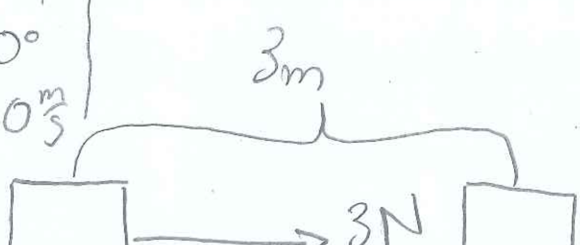
$F \cdot d \cdot \cos\theta = KE_F - \frac{1}{2}mV_i^2$

$(3)(3)(\cos 0°) = KE_F - \frac{1}{2}m(0)^2$

$(9)(1) = KE_F - 0$

$\boxed{KE_F = 9}$

$F = 3N$
$d = 3m$
$\theta = 0°$
$V_i = 0\frac{m}{s}$



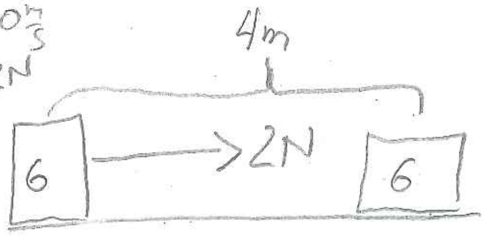
A horizontal 2N force accelerates a 6kg block from rest through a distance of 4m along a smooth level surface.

42) What is the kinetic energy of the block at the end of this journey? (8J)

$m = 6kg \quad d = 4m$

$V_i = 0 \frac{m}{s}$

$F = 2N$



$W = \Delta KE$

$Fd = KE_F - \frac{1}{2}mv_i^2$

$(2)(4) = KE_F - 0$

$\boxed{KE_F = 8J}$

43) Using the equation for kinetic energy determine the velocity of the block at the end of its journey. (1.6 m/s)

$KE_F = \frac{1}{2}mV_F^2$

$V_F^2 = \frac{(2)KE_F}{m}$

$V_F^2 = \frac{2(8J)}{6}$

$V_F = \sqrt{\frac{8}{3}}$

$\boxed{V_F = 1.6 \frac{m}{s}}$

44) Using F=ma determine the acceleration of the block? (0.33 m/s^2)

$F = ma$

$a = \frac{F}{m}$

$a = \frac{2N}{6kg}$

$\boxed{a = 0.33 \frac{m}{s^2}}$

45) Using kinematic equations of motion, determine the final velocity of the block. (1.6 m/s)

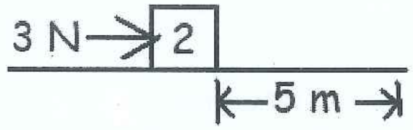
$V_F^2 = V_i^2 + 2ad$

$V_F = \sqrt{V_i^2 + 2ad}$

$V_F = \sqrt{0^2 + 2(0.33)(4m)}$

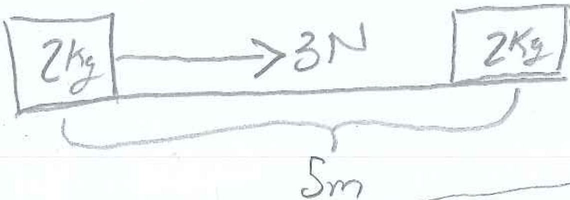
$\boxed{V_F = 1.6 \frac{m}{s^2}}$

16



A 2 kg mass is pushed by a 3 N force through a displacement of +5 m along a smooth table.

46) What is its change in kinetic energy? (15J)



$W = \Delta KE$

$(F)(d)(\cos\theta) = KE_f - KE_i$

$F = 3N$

$m = 2kg$

$d = 5m$

$V_i = 0 \frac{m}{s}$

$(3N)(5m)(\cos 0°) = KE_f - \frac{1}{2}(2kg)(0)^2$

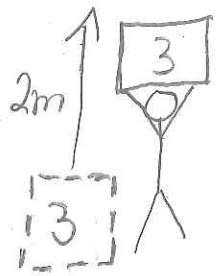
$(15)(1) = KE_f - 0$

$\boxed{KE_f = 15\ J}$

Gravitational Potential Energy

A 3kg block is raised 2m vertically by my lifting force.

47) What is the work performed by my lifting force? (60J)



$$W = \underbrace{F}_{\substack{\Sigma F = 0 \\ F_{lift} - F_{gravity} = 0 \\ F_{lift} - 30N = 0 \\ F_{lift} = 30N}} \cdot d \cdot \cos\theta$$

$W = (30N)(2m)(\cos 0^\circ)$

$W = (30N)(2m)(1)$

$\boxed{W = 60J}$

48) What is the change in potential energy of the block? (60J)

$m = 3kg$

$g = 10 \frac{m}{s^2}$

$h = 2m$

$\Delta PE = m \cdot g \cdot h$

$\Delta PE = (3kg)(10 \frac{m}{s^2})(2m)$

$\boxed{\Delta PE = 60J}$

$g = -10 \frac{m}{s^2}$?

A 2kg block experiences a 50J increase in its potential energy.

49) How far has the block been moved? (2.5m vertically)

$m = 2kg$

$PE = 50J$

$h = ?$

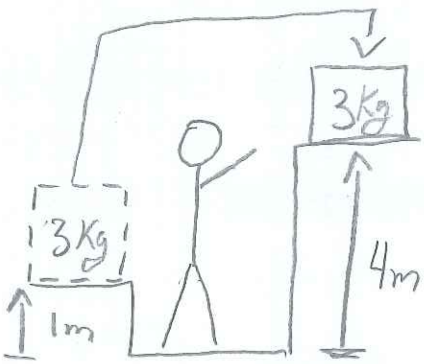
$\Delta PE = m \cdot g \cdot h$

$h = \frac{\Delta PE}{mg}$

$h = \frac{50J}{2kg(10\frac{m}{s^2})}$

$\boxed{h = 2.5m}$

50) A 3 kg mass is raised from a point 1 m above the floor to a point that is 4 m above the floor. What is its change in potential energy? (+90J)



$m = 3kg$

$g = 10\frac{m}{s^2}$

$h = 4 - 1 = 3m$

$\Delta PE = ?$

$\Delta PE = m \cdot g \cdot h$

$\Delta PE = (3kg)(10\frac{m}{s^2})(3m)$

$\boxed{\Delta PE = 90J}$

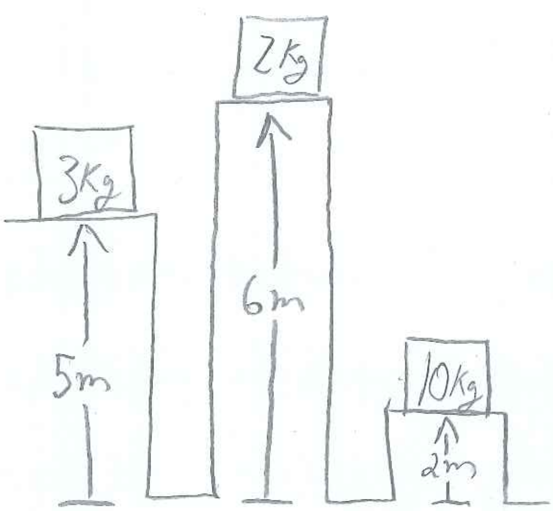
51) Mass A is a 3 kg mass located 5 m above the floor. Mass B is a 2 kg mass located 6 m above the floor. Mass C is a 10 kg mass located 2 m above the floor. Which mass has most potential energy? (C)

$\Delta PE = m g h$

$A = (3)(10)(5) = 150J$

$B = (2)(10)(6) = 120J$

$C = (10)(10)(2) = \boxed{200J}$



19

$$\boxed{F_R = -K\Delta X}$$

Spring Potential Energy

An applied force of 2N causes a spring to extend by 4m.

52) What is the spring constant of the spring? (0.5N/m)

F_R ⟵ ⟶ F_A 2N

$-2N$

$F_R = -2N$

$\Delta X = 4m$

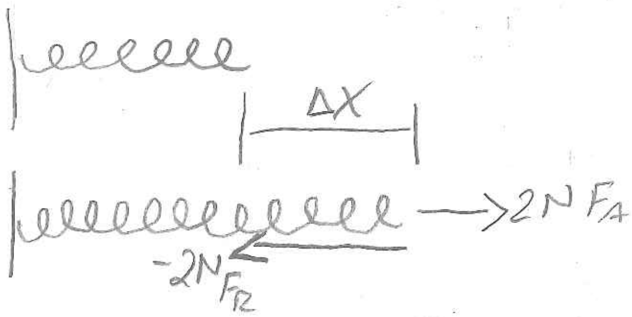
$F_R = -K\Delta X$

$$K = -\frac{F_R}{\Delta X}$$

$$K = \frac{-(-2N)}{4m}$$

$$\boxed{K = \frac{1}{2}\frac{N}{m}}$$

53) How much spring potential energy is stored in the stretched spring? (4J)



$$\boxed{PE_{spring} = \frac{1}{2}K(\Delta X)^2}$$

$$PE_s = \frac{1}{2}\left(0.5\frac{N}{m}\right)(4)^2$$

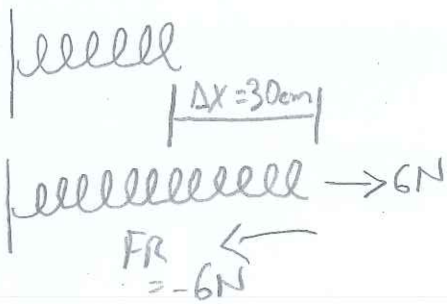
$$PE_s = \frac{1}{4}(16)$$

$$\boxed{PE_s = 4J}$$

20

An applied force of 6N causes a spring to extend by 30cm.

54) What is the spring constant of the spring? (20N/m)



$F_R = -K\Delta X$

$K = -\frac{F_R}{\Delta X}$

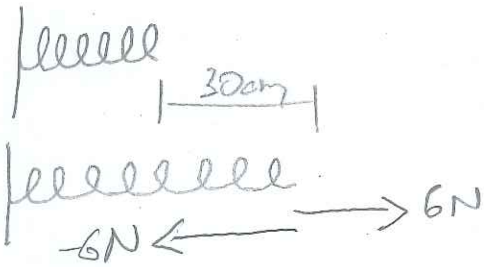
$K = -\frac{F_R}{\Delta X}$

$K = -\frac{(-6N)}{30\times 10^{-2}m}$

$K = \frac{6N}{.30m}$

$\boxed{K = 20\frac{N}{m}}$

55) How much spring potential energy is stored in the stretched spring? (0.9J)



$\Delta PE_s = \frac{1}{2}K(\Delta X)^2$

$\Delta X = 30cm$

$\Delta X = 0.30m$

$\Delta PE = \frac{1}{2}K(\Delta x)^2$

$\Delta PE = \frac{1}{2}20\frac{N}{m}(0.30m)^2$

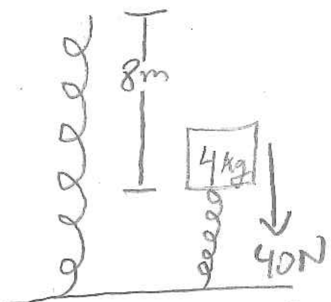
$\Delta PE = \frac{1}{2}20\frac{N}{m}(0.09m)$

$\Delta PE_s = 10\frac{N}{m}(0.09m)$

$\boxed{\Delta PE_s = 0.9J}$

A 4kg mass rests on a vertical spring. The mass cause the spring to compress by 8m.

56) What is the spring constant of the spring? (5N/m)



Weight = 40N = F_R

$\Delta X = -8m$

$$F_R = -K\Delta X$$

$$K = -\frac{F_R}{\Delta X}$$

$$K = \frac{-(40N)}{-8m}$$

$$\boxed{K = 5\frac{N}{m}}$$

57) How much spring potential energy is stored in the compressed spring? (160J)

$$\Delta PE_s = \frac{1}{2}K(\Delta X)^2$$

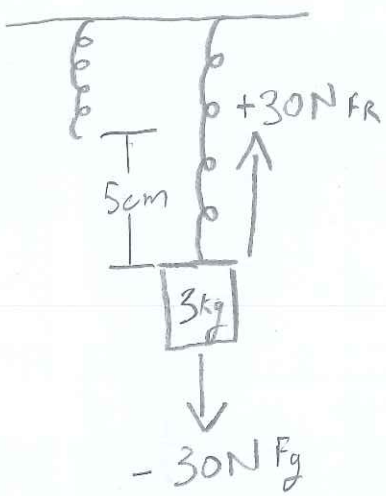
$$\Delta PE_s = \frac{1}{2}(5)(-8)^2$$

$$\boxed{\Delta PE_s = 160\text{ J}}$$

22

A 3kg mass hangs from a vertical spring. The mass cause the spring to extend by 5cm.

58) What is the spring constant of the spring? (600N/m)



$F_R = -k\Delta X$

$K = \dfrac{-F_R}{\Delta X}$

$K = \dfrac{-(30N)}{(-.05m)}$

$\boxed{K = 600 \frac{N}{m}}$

59) How much spring potential energy is stored in the compressed spring? (0.75J)

$\Delta PE_s = \frac{1}{2} k(\Delta X)^2$

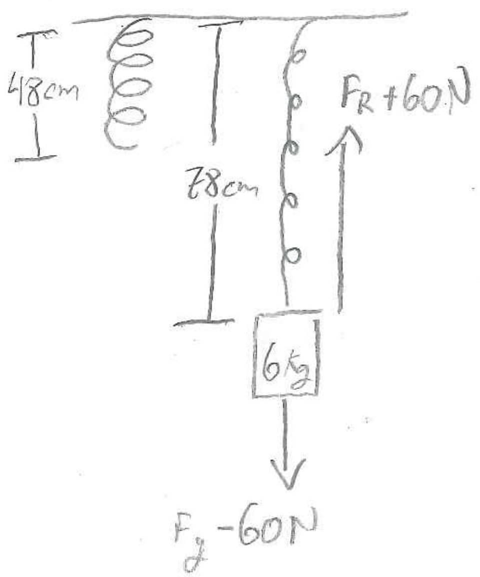
$\Delta PE_s = \frac{1}{2}(600)(.05)^2$

$\Delta PE_s = 300(.0025)$

$\boxed{\Delta PE_s = 0.75\ J}$

A 6kg mass hangs from a spring that has an equilibrium length of 48cm. The mass causes the spring to extend to 78cm.

60) What is the spring constant of the spring? (200N/m)



$\Delta X = 78cm - 48cm$

$\Delta X = 30cm$

$\Delta X = -0.30m$

$F_R = 60N$

$F_R = -k\Delta X$

$k = \frac{-F_R}{\Delta X}$

$k = \frac{-60N}{-0.30m}$

$\boxed{k = 200 \frac{N}{m}}$

61) How much spring potential energy is stored in the compressed spring? (9J)

$\Delta PE_s = \frac{1}{2} k(\Delta x)^2$

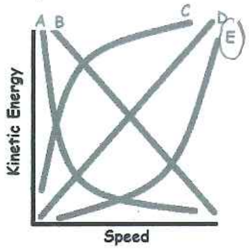
$\Delta PE_s = \frac{1}{2}(200)(0.30m)^2$

$\Delta PE_s = 100(.30m)^2$

$\boxed{\Delta PE_s = 9J}$

2048 Energy Conservation Homework

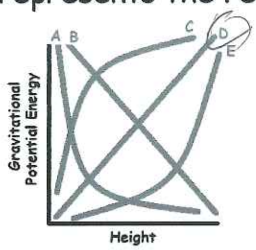
1) A block travels in a straight line. Its speed can be changed. Which trace best represents the relationship between Kinetic Energy and speed?



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

E

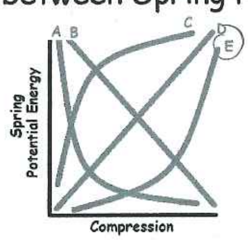
2) A block can be raised vertically in a gravitational force field. Which trace best represents the relationship between Gravitational Potential Energy and height?



$PE = mgh$

D

3) A block can be pushed into a spring. Which trace best represents the relationship between Spring Potential Energy and compression?



$U_s = \frac{1}{2}k(\Delta x)^2$

E

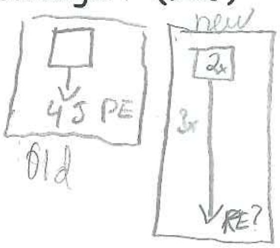
4) A block travels in a straight line. It has 6J of Kinetic Energy. What would be the kinetic Energy of another block if it had twice the mass and three times the speed? (108J)

$\frac{KE}{KE_0} = \frac{\cancel{\frac{1}{2}}mv^2}{\cancel{\frac{1}{2}}mv^2} = \frac{KE}{6} = \frac{2(3)^2}{1 \cdot 1^2}$

$\frac{KE}{6} = 18 \rightarrow KE = 18 \cdot 6 = \boxed{108\text{ J}}$

5) A block travels in a straight line. It has 2J of Kinetic Energy. What would be the kinetic Energy of another block if it had quadrupled the mass and half the speed? (2J)

6) A block is located in a Gravitational Force Field. It has 4J of Gravitational Potential Energy. What would be the Gravitational Potential Energy of another block that has twice the mass, is located three times higher and is in a force field that is 4 times stronger? (96J)

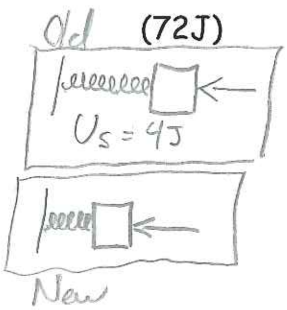


$$\frac{PE = mgh}{PE_0 = mgh} \rightarrow \frac{PE}{4J} = \frac{2(4)(3)}{(1)(1)(1)}$$

$$\frac{PE}{4} = \frac{24}{1} \rightarrow PE = 4(24) \quad \boxed{PE = 96}$$

7) A block is located in a Gravitational Force Field. It has 2J of Gravitational Potential Energy. What would be the Gravitational Potential Energy of another block that has three times the mass, is located two times higher and is in a force field that is one quarter times as strong? (3J)

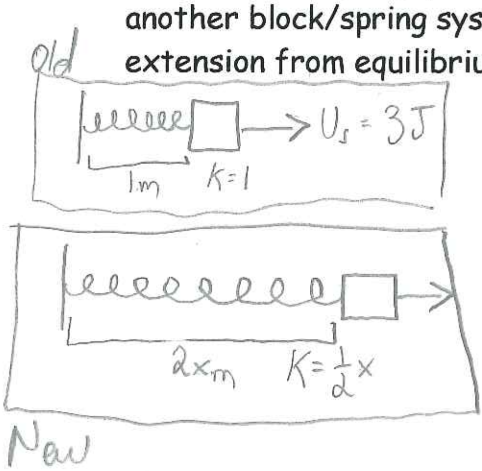
8) A block is pushed into a spring. It causes a spring potential energy of 4J. What is the spring potential energy of another block/spring system if the spring constant is twice as big and the spring's compression from equilibrium is three times greater? (72J)



$$\frac{U_s = \frac{1}{2}K(\Delta x)^2}{U_{s_{old}} = \frac{1}{2}K(\Delta x)^2} \rightarrow \frac{U_s}{4} = \frac{2(3)^2}{(1)(1)^2}$$

$$\frac{U_s}{4} = \frac{18}{1} \rightarrow U_s = 4(18) \rightarrow \boxed{U_s = 72J}$$

9) A block is attached to a spring. The block is pulled so that the spring is stretched. This causes a spring potential energy of 3J. What is the spring potential energy of another block/spring system if the spring constant is half as big and the spring extension from equilibrium is two times longer? (6J)



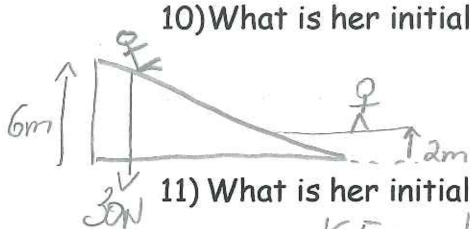
$$\frac{U_s = \frac{1}{2}K(\Delta x)^2}{U_{s_{old}} = \frac{1}{2}K(\Delta x)^2} \rightarrow \frac{U_s}{3} = \frac{(\frac{1}{2})(2)^2}{(1)(1)^2}$$

$$\frac{U_s}{3} = \frac{\frac{1}{2}(4)}{1} \rightarrow U_s = 3 \cdot 2 \rightarrow \boxed{U_s = 6J}$$

Isolated Systems

A 3kg student slides down a smooth frictionless playground slide. Her starting point is 6m above the ground. Her endpoint is 2m above the ground. She starts from rest.

10) What is her initial PE relative to the ground? (180J)



$PE_i = mgh \rightarrow (3kg)(10\frac{m}{s^2})(6m)$

$\boxed{PE_i = 180J}$

11) What is her initial KE relative to the ground? (0J)

$KE_i = \frac{1}{2}mv^2 \rightarrow \frac{1}{2}(3Kg)(0)^2$

$\boxed{KE_i = 0J}$

12) What is her initial mechanical energy (ME) relative to the ground? (180J)

$ME_i = KE_i + PE_i \rightarrow ME_i = 0 + 180J$

$\boxed{ME_i = 180J}$

13) What is her final PE relative to the ground? (60J)

$PE_F = mgh \rightarrow (3kg)(10\frac{m}{s^2})(2m) \rightarrow \boxed{PE_F = 60J}$

14) What is her change in ME? (0J – because she is in an 'isolated system')

$\Delta ME = ME_F - ME_i$

$\boxed{\Delta ME = 0J \text{ because of isolated frictionless system}}$

15) What is her final KE? (120J)

$\Delta ME = ME_F - ME_i \rightarrow [PE_i + KE_i] - [PE_F - KE_F] = [180J + 0J] - [60J + KE_F]$

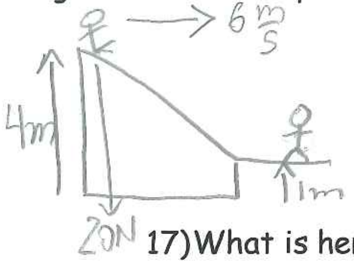
$0J = [180J] - 60J - KE_F \rightarrow KE_F = 180J - 60J \rightarrow \boxed{KE_F = 120J}$

16) What is her final speed? (9m/s)

$KE_F = \frac{1}{2}mv^2 \rightarrow V^2 = \frac{2KE_F}{m} \rightarrow V = \sqrt{\frac{2KE_F}{m}}$

$V = \sqrt{\frac{2(120)}{3}} \rightarrow V = \sqrt{80} \rightarrow \boxed{V = 8.9\frac{m}{s}}$

A 2kg student slides down a frictionless playground slide. Her starting point is 4m above the ground. Her endpoint is 1m above the ground. She starts with a speed of 6m/s.



$m = 2Kg$
$V_i = 6\frac{m}{s}$
$h_i = 4m$

$m = 2Kg$
$V_f = ?$
$h_f = 1m$

$V_f^2 = V_i^2 + 2a\Delta x$
$V_f = \sqrt{6^2 + 2(-10)(3)}$ → Vertical
$\boxed{\cancel{V_f = \sqrt{24}\frac{m}{s}}}$?

17)What is her initial PE relative to the ground? (80J)

$PE_i = mgh \rightarrow (2)(10)(4)$

$\boxed{PE_i = 80J}$

18)What is her initial KE relative to the ground? (36J)

$KE_i = \frac{1}{2}mv^2 \rightarrow \frac{1}{2}(2)(6)^2$

$\boxed{KE_i = 36J}$

19)What is her initial mechanical energy (ME) relative to the ground? (116J)

$ME_i = PE_i + KE_i \rightarrow ME_i = 80J + 36J$

$\boxed{ME_i = 116J}$

20) What is her final PE relative to the ground? (20J)

$PE_F = mgh \rightarrow PE_F = (2)(10)(1)$

$\boxed{PE_F = 20J}$

21)What is her change in ME? (0J - Do you know why?)

$\boxed{\Delta ME = 0J \text{ for isolated system. It's frictionless}}$

22) What is her final KE? (96J)

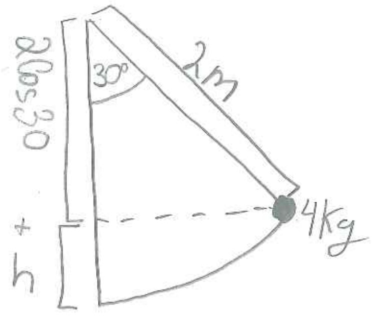
$\Delta ME = ME_F - M_i \rightarrow 0J = [PE_F + KE_F] - [PE_i + KE_i]$

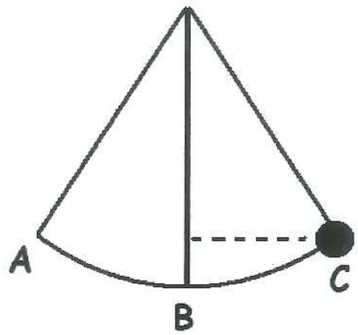
$0J = [20J + KE_F] - [80J + 36J] \rightarrow 0 = KE_F - 96J \rightarrow \boxed{KE_F = 96J}$

23) What is her final speed? (9.8m/s)

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

$V = \sqrt{\frac{2KE_F}{m}} \rightarrow V = \sqrt{\frac{2(96)}{2}} \rightarrow \boxed{V = 9.8\frac{m}{s}}$? Kinematics





$L = h + 2\cos 30 \rightarrow 2m = h + 2\cos 30 \rightarrow h = 2 - 2\cos 30$

A pendulum swings out 30 degrees from the vertical axis. The pendulum is 2m long. It has a 4kg bob.

24) Where does the pendulum have LEAST gravitational potential energy? (B)

Least PE @ point $\boxed{B}$ where it has greatest KE

25) What is the pendulum's gravitational potential energy at point C? (10.8J relative to its lowest position, B)

$PE_c = mgh_c \rightarrow (4)(10)(h_c) \rightarrow (4)(10)(2 - 2\cos 30)$

$\boxed{PE_c = 10.7J}$

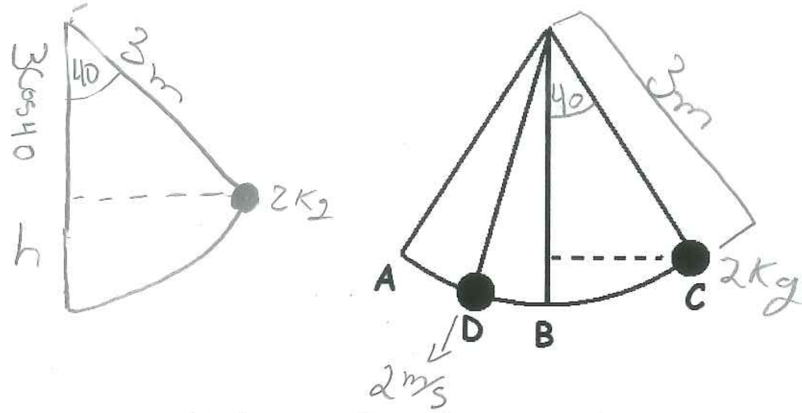
26) What is the pendulum's speed at point B? (2.3m/s)

$KE_B = \frac{1}{2}mv^2 \rightarrow 10.7J = \frac{1}{2}(4)(v^2) \rightarrow V = \sqrt{\frac{2(10.7)}{4}}$

$ME_B = PE_B + KE_B$
$10.7J = 0J + KE_B$
$KE_B = 10.7J$

$V = \sqrt{5.35}$

$\boxed{V = 2.3\frac{m}{s}}$



A pendulum swings out 40 degrees from the vertical axis. It is 3m long. It has a 2kg bob. At point D the bob has a speed of 2.0m/s.

27) What is the pendulum's gravitational potential energy at point C? (14J relative to its lowest position)

$PE_c = mgh_c = PE = (2)(10)(3 - 3\cos 40)$

$L = h_c + 3\cos 40$

$\boxed{PE_c = 14J}$

$h_c = 3m - 3\cos 40$

$h_c =$

28) What is the bob's speed at point B? (3.7m/s)

$KE_B = \frac{1}{2}mv^2 \longrightarrow V = \sqrt{\frac{2KE_B}{m}}$

$ME_B = ME_c = mgh = PE_c$

$ME_B = PE_B + KE_B$

$14J = 0J + KE_B$

$KE_B = 14J$

$V = \sqrt{\frac{2(14)}{2}}$

$\boxed{V = 3.7\frac{m}{s}}$

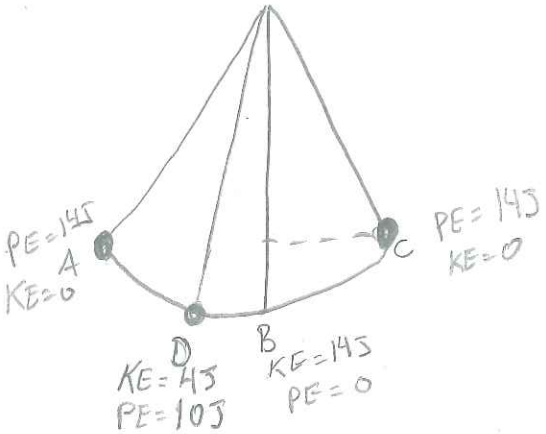
29) What is the bob's kinetic energy at point D? (4J)

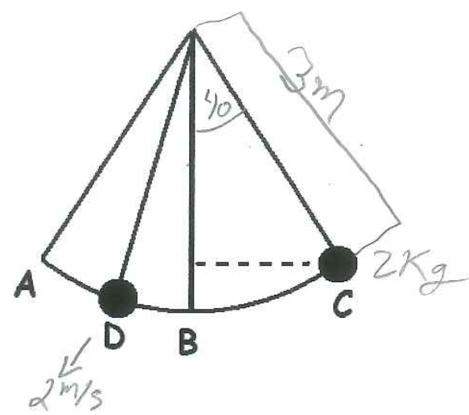
$KE_D = \frac{1}{2}mv^2$

$KE_D = \frac{1}{2}(2)(2)^2$

$\boxed{KE_D = 4J}$

$ME = KE + PE$





$h = 3 - 3\cos 40$

A pendulum swings out 40 degrees from the vertical axis. It is 3m long. It has a 2kg bob. At point D the bob has a speed of 2.0m/s.

30) What is the bob's gravitational potential energy at point D? (10J relative to lowest point)

$ME_B = \frac{1}{2}mv^2 = ME_C = mgh_c = (2)(10)(3-3\cos 40) = 14J$

$\underbrace{\Delta ME_{BD}}_{\text{Zero b/c it's an isolated system}} = ME_B - ME_D \longrightarrow 0J = 14 - [PE_D + \frac{1}{2}mv^2]$

$0J = 14 - PE - 4 \longrightarrow PE_D = 14 - 4$

$\boxed{PE_D = 10J}$

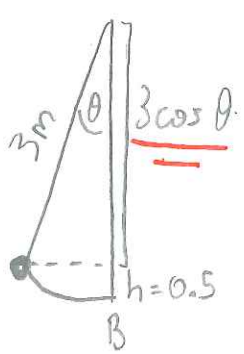
31) How much higher is point D than Point B? (0.5m)

$PE_D = mgh \longrightarrow h = \frac{PE_D}{mg}$

$h = \frac{10}{2(10)}$

$\boxed{h = 0.5m}$

32) When at point D, what angle does the pendulum make to the vertical? (33.6 degrees)



$L = h + \underline{3\cos\theta}$

$3 = 0.5 + 3\cos\theta$

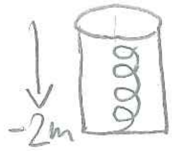
$3\cos\theta = 2.5$

$\cos\theta = \frac{2.5}{3}$

$\theta = \cos^{-1}\left(\frac{2.5}{3}\right) \longrightarrow \boxed{\theta = 33.6°}$

A vertical spring-loaded cannon has a spring constant of 4N/m.

33) What force is required to compress the spring by 2m? (8N)



$K = 4\frac{N}{m}$

$\Delta X = -2m$

$F_R = ?$

$F_R = -K\Delta X$

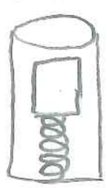
$F_R = (-4\frac{N}{m})(-2m)$

$\boxed{F_R = +8N}$

34) How much spring potential energy is stored in the spring when it is compressed by 2m? (8J)

$\Delta X = -2m$

$K = 4\frac{N}{m}$



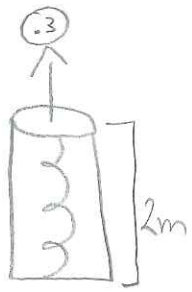
$U_s = \frac{1}{2}K(\Delta X)^2$

$U_s = \frac{1}{2}(4\frac{N}{m})(-2m)^2$

$U_s = 2\frac{N}{m}(4m^2)$

$\boxed{U_s = 8J}$

35) What speed would a 0.3kg cannonball have as it leaves the spring? (3.65 m/s)

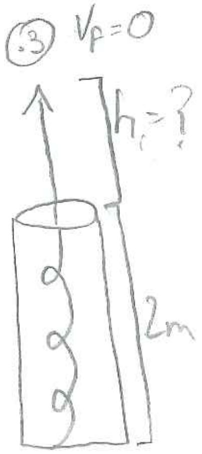


$KE = U_s - PE \rightarrow \frac{1}{2}mv^2 = 8J - mgh$

$\frac{1}{2}mv^2 = 8 - [0.3(10)(2)] \rightarrow \frac{1}{2}mv^2 = 8 - 6$

$v^2 = \frac{2(2)}{0.3} \rightarrow v = \sqrt{\frac{4}{0.3}} \rightarrow \boxed{v = 3.65\frac{m}{s}}$

36) How high would a 0.3kg cannonball climb $\boxed{\text{above the spring}}$ if it were fired vertically? (0.66m)



$mgh_c = KE_f - U_s \rightarrow mgh_c = \frac{1}{2}mv^2 - 8J$

$mgh_c = 0 - 8J \rightarrow [2m + h] = h_c$

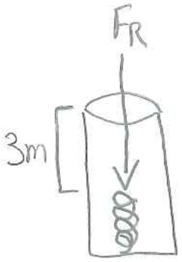
$mg[2m + h] = 8J \rightarrow 2m + h = \frac{8}{mg}$

$2m + h = \frac{8}{3} \rightarrow 2m + h = 2.66$

$h = 2.66 - 2 \rightarrow \boxed{h = 0.66}$

A spring-loaded cannon has a spring constant of 8N/m.

37) What force is required to compress the spring by 3m? (24N)



$K = 8\frac{N}{m}$ | $F_R = -K\Delta X$

$\Delta X = -3m$ | $F_R = -(8\frac{N}{m})(-3m)$

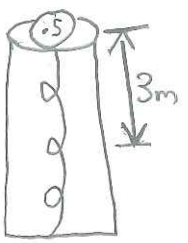
$F_R = ?$ | $\boxed{F_R = 24N}$

38) How much spring potential energy is stored in the spring when it is compressed by 3m? (36J)

$$U_s = \frac{1}{2}K(\Delta x)^2 \longrightarrow U_s = \frac{1}{2}(8)(3)^2$$

$$U_s = 4(9) \longrightarrow \boxed{U_s = 36\ J}$$

39) What speed would a 0.5kg cannonball have as it leaves the spring? (9.2 m/s)



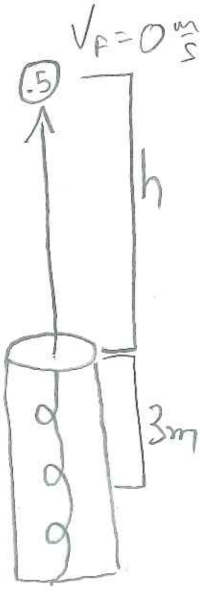
$$KE = U_s - PE \longrightarrow KE = 36J - [mgh]$$

$$KE = 36 - [0.5(10)(3)] \longrightarrow KE = 36 - 15$$

$$KE = 21J \longrightarrow \frac{1}{2}mv^2 = 21 \longrightarrow V^2 = \frac{2(21)}{0.5}$$

$$V = \sqrt{84} \longrightarrow \boxed{V = 9.2\frac{m}{s}}$$

40) How high would a 0.5kg cannonball climb above the spring if it were fired vertically? (4.2m)



$$PE = U_s - KE \longrightarrow mg(3+h) = 36J - 0$$

$$0.5(10)(3+h) = 36$$

$$3 + h = \frac{36}{5} \longrightarrow 3+h = 7.2$$

$$h = 7.2 - 3$$

$$\boxed{h = 4.2m}$$

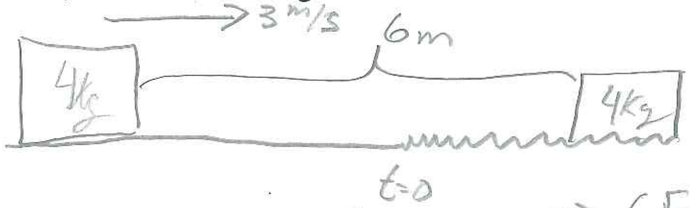
?

Why do you have to take into acct $\boxed{3}+h$?

Work Done by Non-conservative Forces

A 4kg sled has a speed of 3m/s as it travels across smooth frictionless ice. At time t=0s it runs over a patch of snow and comes to rest after 6m.

41) What is the magnitude of the friction force between the sled and the snow? (3N)



$ME_f = ME_i + W_{FR}$

$ME_f = KE_i + (-F_f)(d)$

$ME_f = \frac{1}{2}(4)(3)^2 + (-F_f)(6)$

$ME_f = 18J - 6F_f$

$KE_f = 18J - 6F_f$

$6F_f + \frac{1}{2}m(0)^2 = 18J$

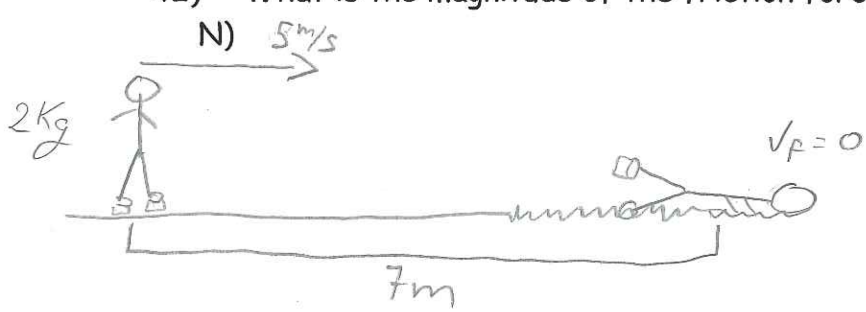
$6F_f + 0 = 18J$

$6F_f = 18J$

$\boxed{F_f = 3N}$

A 2kg skier has a speed of 5m/s as she travels across frictionless ice. At time t=0s she runs over a patch of snow and comes to rest after 7m.

42) What is the magnitude of the friction force between the skier and the snow? (3.6 N)



$ME_f = ME_i + W_{FR}$

$ME_f = KE_i + (-F_f)(d)$

$ME_f = \frac{1}{2}(2)(5)^2 - F_f(7)$

$KE_f = 25J - 7F_f$

$7F_f + \frac{1}{2}m(V_f)^2 = 25J$

$7F_f + \frac{1}{2}(2)(0) = 25J$

$7F_f + 0 = 25J$

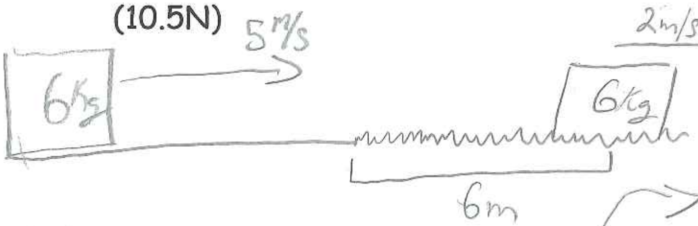
$F_f = \frac{25}{7}$

$\boxed{F_f = 3.6N}$

A 6kg sled has a speed of 5m/s as it travels across smooth frictionless ice. At time t=0s it runs over a patch of snow and slows to a speed of 2m/s after traveling 6m across the snow.

43) What is the magnitude of the friction force between the sled and the snow?

(10.5N)



$ME_F = ME_i + W_{FR}$

$ME_F = KE_i - F_F(d)$

$\frac{1}{2}m(v_F)^2 = \frac{1}{2}m(v_i)^2 - F_F(6m)$

$\frac{1}{2}(6)(2)^2 = \frac{1}{2}(6)(5)^2 - 6F_F$

$12J = 75J - 6F_F$

$6F_F = 75J - 12J$

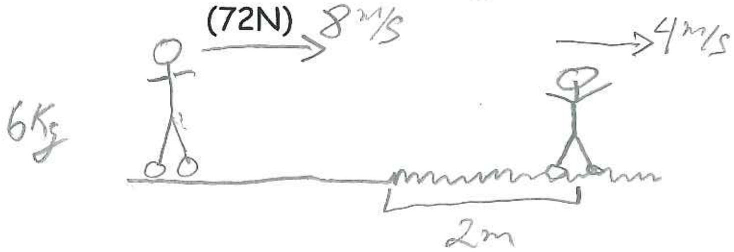
$F_F = \frac{63J}{6}$

$\boxed{F_F = 10.5N}$

A 6kg skier has a speed of 8m/s as it travels across smooth frictionless ice. At time t=0s it runs over a patch of snow and slows to a speed of 4m/s after traveling 2m across the snow.

44) What is the magnitude of the friction force between the skier and the snow?

(72N)



$ME_F = ME_i + W_{FR}$

$ME_F = ME_i - F_F(d)$

$\frac{1}{2}m(v_F)^2 = \frac{1}{2}m(v_i)^2 - F_F(2)$

$3(4)^2 = 3(8)^2 - 2F_F$

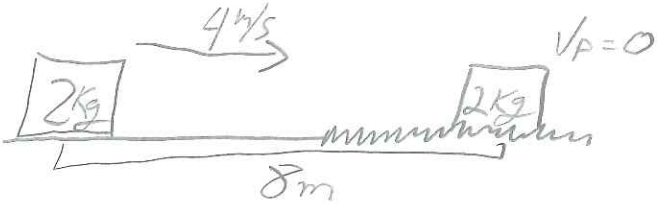
$2F_F = 192J - 48J$

$2F_F = 144J$

$\boxed{F_F = 72N}$

A 2kg block slides across a smooth level surface with a constant speed of 4m/s. It slides onto a rough part of the surface and comes to rest in 8m.

45) What is the average force of friction as the block slides across the rough surface? (2N)



$ME_F = ME_i + W_{FR}$

$KE_F = \frac{1}{2}mv_i^2 - F_F(d)$

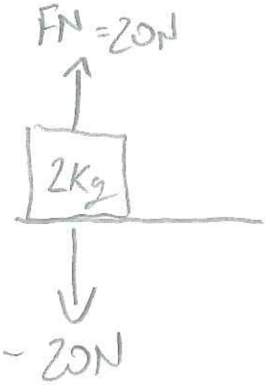
$\frac{1}{2}m(0) = \frac{1}{2}(2)(4)^2 - 8F_F$

$8F_F + 0 = 16J \longrightarrow F_F = \frac{16}{8}$

$\boxed{F_F = 2N}$

46) What is the coefficient of kinetic friction between the block and the rough surface? (0.1)

$F_F = \mu_{FFK} F_N \longrightarrow \mu_K = \frac{F_{FK}}{F_N} \longrightarrow \mu_K = \frac{2N}{20N}$



$\Sigma F_V = 0$

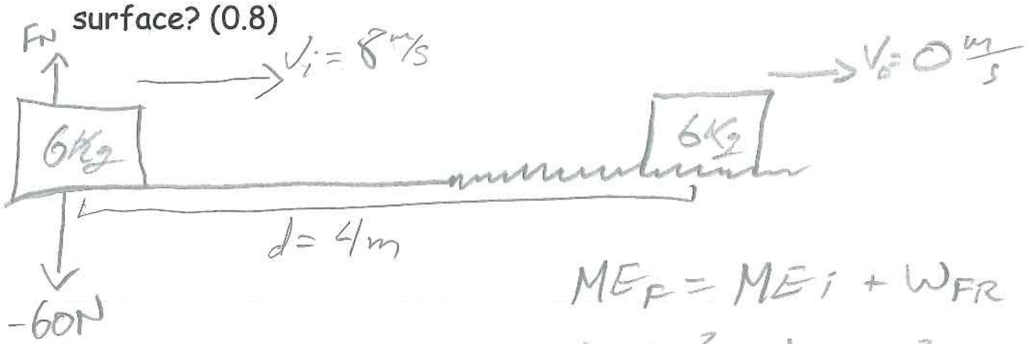
$F_N + (-20N) = 0$

$F_N = +20N$

$\boxed{\mu_K = 0.1}$

A 6kg block slides across a smooth level surface with a constant speed of 8m/s. It slides onto a rough part of the surface and comes to rest in 4m.

47) What is the coefficient of kinetic friction between the block and the rough surface? (0.8)



$$\Sigma F_V = 0$$

$$FN - 60N = 0$$

$$FN = 60N$$

$$ME_F = ME_i + W_{FR}$$

$$\frac{1}{2}m(V_F)^2 = \frac{1}{2}m(V_i)^2 + (-F_F)(4)$$

$$\frac{1}{2}m(0) = \frac{1}{2}(6)(8)^2 - 4F_F$$

$$4F_F = 3(64)$$

$$F_F = \frac{192}{4}$$

$$F_F = 48\,N$$

$$F_F = \mu_K FN$$

$$48N = \mu_K(60N)$$

$$\mu_K = \frac{48N}{60N}$$

$$\boxed{\mu_K = 0.8}$$

A 6kg block slides across a smooth level surface with a constant speed of 9m/s. It slides onto a rough part of the surface and slows to 4m/s in 5m.

48) What is the coefficient of kinetic friction between the block and the rough surface? (0.65)

Average Power

$$\bar{P} = \frac{W}{\Delta T}$$

49) A motor performs 20 J of work in 4s. What is the average power dissipated by the motor during this job? (5 W)

$W = 20J$

$T = 4s$

$$\bar{P} = \frac{W}{\Delta T}$$

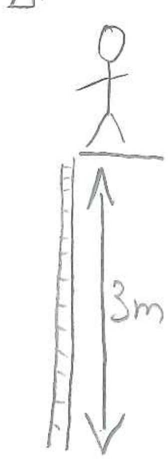
$$\bar{P} = \frac{20J}{4s}$$

$$\boxed{\bar{P} = 5 \text{ Watts}}$$

50) A 4N student climbs a 3m wall in 6s. What is the average power dissipated by the student during this task? (2W)

$$\bar{P} = \frac{W}{\Delta T}$$

$\Delta T = 6s$



$W = F \cdot d \cos\theta$

$W = 4N \cdot 3m \cdot \cos 0°$

$W = 4 \cdot 3 \cdot 1$

$W = 12J$

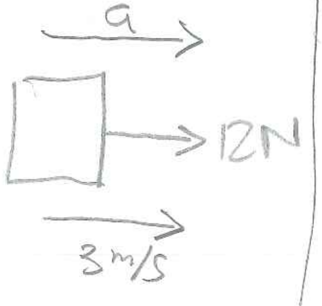
$$\bar{P} = \frac{12J}{6s}$$

$$\boxed{\bar{P} = 2 \text{ watts}}$$

$$P = \frac{dW}{dt} =$$

Instantaneous Power

51) An applied force of 12N causes a block to accelerate. At one instant in time the block has a velocity of 3m/s. What is the instantaneous power being dissipated by the force at that instant? (36 W)



$F = 12N$

$V = 3 \frac{m}{s}$

$P = ?$

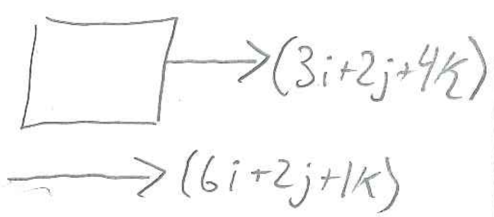
$P = F \bullet V$

$P = |F||V| \cos\theta$

$P = (12)(3) \cos 0°$

$\boxed{P = 36 \text{ Watts}}$

52) An applied force of (3i+2j+4k)N causes a spaceship to have a velocity of (6i+2j+1k)m/s. What is the instantaneous power being dissipated by the spaceship at this instant? (26W)



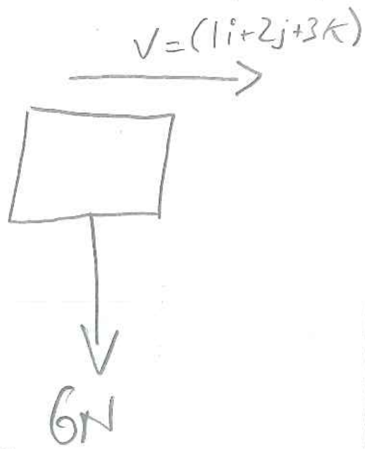
$P = \vec{F} \bullet \vec{V}$

$P = (3)(6) + (2)(2) + (4)(1)$

$P = 18 + 4 + 4$

$\boxed{P = 26 \text{ watts}}$

53) An force of 6N along the negative Y-axis causes a spaceship to have a velocity of (1i+2j+3k)m/s. What is the instantaneous power being dissipated by the spaceship at this instant? (-12W)



$= (0i - 6j + 0k)$

$F = (0i - 6j + 0k)N$

$V = (1i + 2j + 3k)\frac{m}{s}$

$P = \vec{F} \bullet \vec{V}$

$P = (0)(1) + (-6)(2) + (0)(3)$

$P = 0 - 12 + 0$

$\boxed{P = -12 \text{ watts}}$

A spring-loaded cannon has a spring constant of 8N/m.

37) What force is required to compress the spring by 3m? (24N)

38) How much spring potential energy is stored in the spring when it is compressed by 3m? (36J)

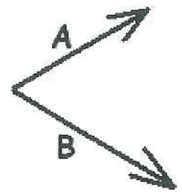
39) What speed would a 0.5kg cannonball have as it leaves the spring? (9.2 m/s)

40) How high would a 0.5kg cannonball climb above the spring if it were fired vertically? (4.2m)

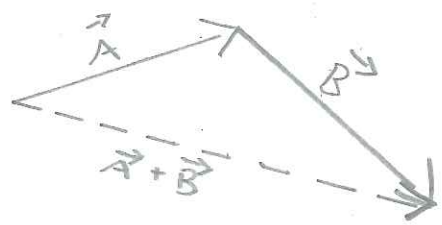
Vectors Homework

Vector Diagrams

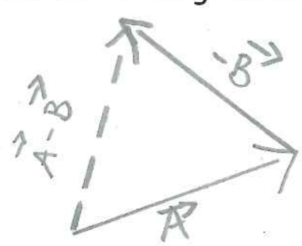
Consider these force vectors.



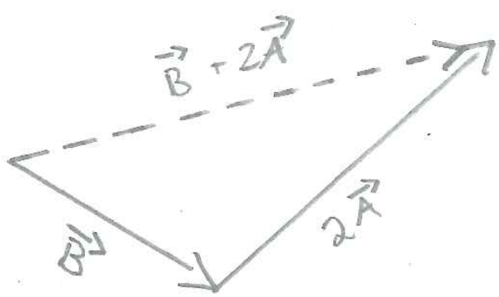
1) Draw a vector diagram to determine **A+B**



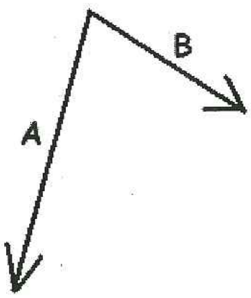
2) Draw a vector diagram to determine **A-B**



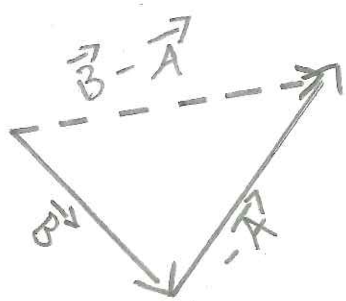
3) Draw a vector diagram to determine **B+2A**



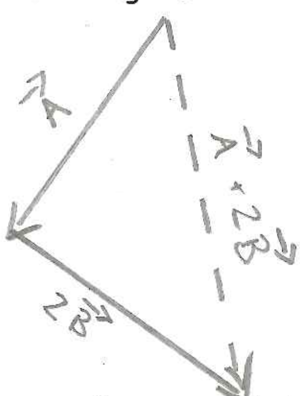
Consider these force vectors.



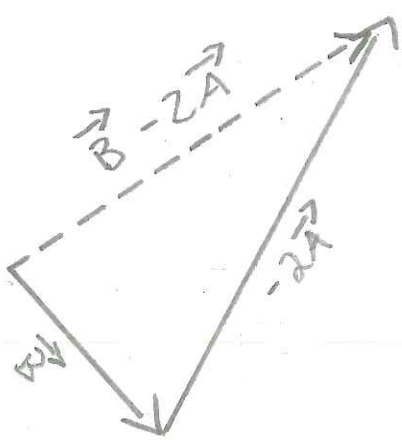
4) Draw a vector diagram to determine **B−A**



5) Draw a vector diagram to determine **A**+2**B**



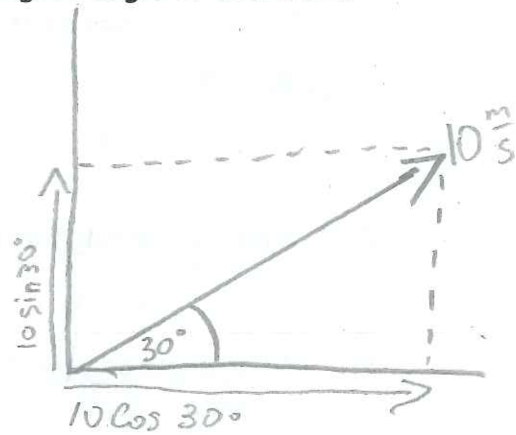
6) Draw a vector diagram to determine **B**-2**A**



Vector Components

A football has been kicked at 10 m/s along a line that has a 30 degree angle of elevation.

7) Draw a diagram of this.



8) What is its initial X component of velocity?

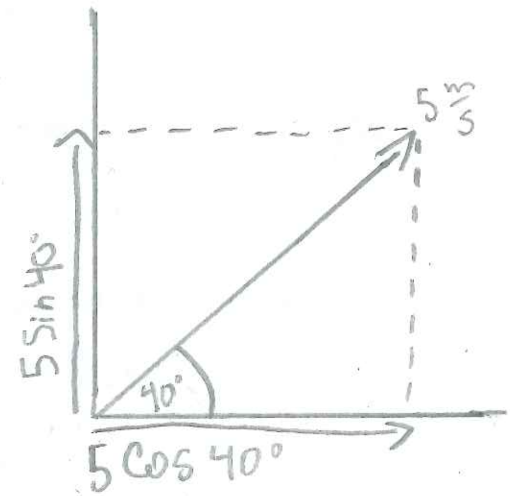
$10\cos 30° = \boxed{8.7 \frac{m}{s}}$

9) What is its initial Y component of velocity?

$10\sin 30° = \boxed{5.0 \frac{m}{s}}$

A football has been kicked at 5m/s along a line that has a 40 degree angle of elevation.

10) Draw a diagram of this.



11) What is its initial X component of velocity?

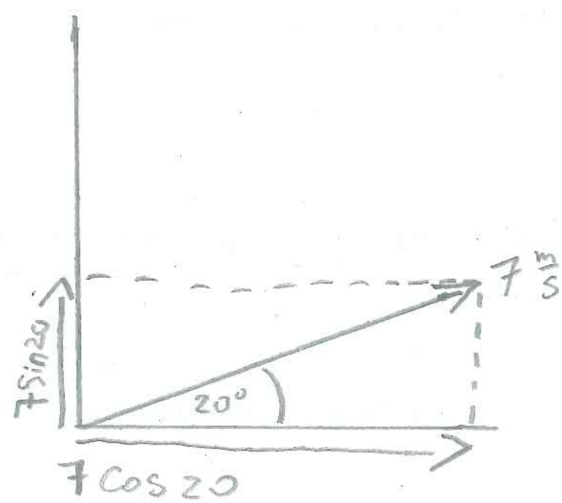
$5\cos 40° = \boxed{3.8 \frac{m}{s}}$

12) What is its initial Y component of velocity?

$5\sin 40° = \boxed{3.2 \frac{m}{s}}$

A football has been kicked at 7m/s along a line that has a 20 degree angle of elevation.

13) Draw a diagram of this.



14) What is its initial X component of velocity?

$7\cos 20 = \boxed{6.6 \frac{m}{s}}$

15) What is its initial Y component of velocity?

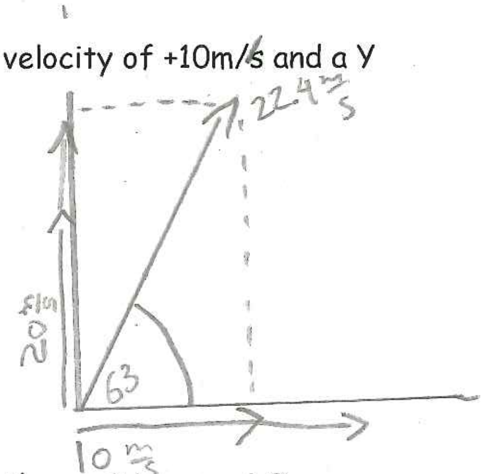
$7\sin 20 = \boxed{2.4 \frac{m}{s}}$

A football has been kicked such that it has an X component of velocity of +10m/s and a Y component of velocity of +20m/s.

16) Draw a diagram of this.

$22.4\cos\theta = 10 \quad = \quad \theta = \cos^{-1}\left(\frac{10}{22.4}\right) = \boxed{63.49^\circ}$

$22.4\sin\theta = 20 \quad \theta = \sin^{-1}\left(\frac{20}{22.4}\right) = 63.2$



17) What is the magnitude of its actual velocity?

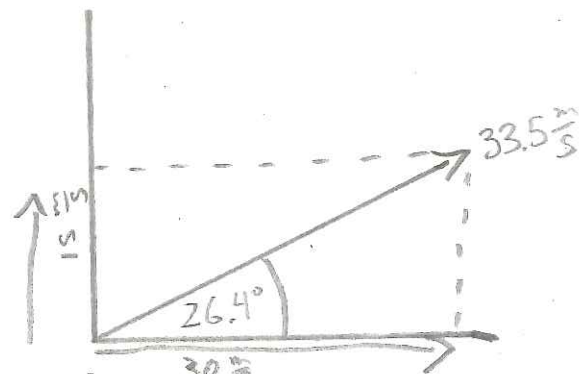
$mag = \sqrt{10^2 + 20^2} = 22.4\frac{m}{s}$

18) What angle of elevation does it have with respect to the positive x-axis?

$\boxed{\theta = 63.4}$

A football has been kicked such that it has an X component of velocity of +30m/s and a Y component of velocity of +15m/s.

19) Draw a diagram of this.



20) What is the magnitude of its actual velocity?

$mag = \sqrt{30^2 + 15^2} = \boxed{mag = 33.5\frac{m}{s}}$

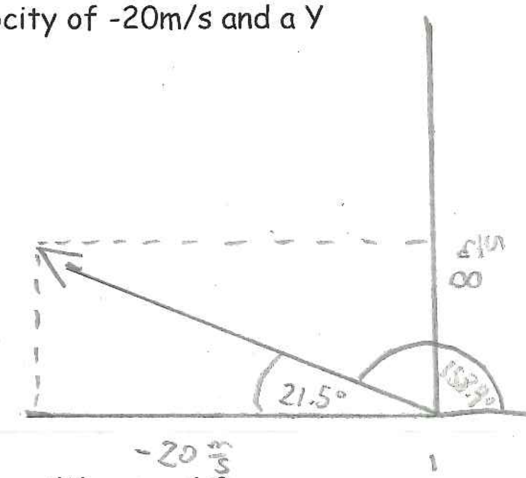
21) What angle of elevation does it have with respect to the positive x-axis?

$33.5\cos\theta = 30$

$\theta = \cos^{-1}\left(\frac{30}{33.5}\right) \quad \boxed{\theta = 26.4^\circ}$

A football has been kicked such that it has an X component of velocity of -20m/s and a Y component of velocity of +8m/s.

22) Draw a diagram of this.



23) What is the magnitude of its actual velocity?

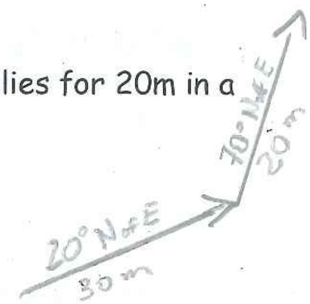
$mag = \sqrt{(-20)^2 + 8^2} = \boxed{Mag = 21.5\frac{m}{s}}$

24) What angle of elevation does it have with respect to the positive x-axis?

$-21.5\cos\theta = -20\frac{m}{s} \longrightarrow \theta = \cos^{-1}\left(\frac{-20}{-21.5}\right) \quad \theta = 21.53$

$\theta = 180 - 21.53$

$\theta = 158.47^\circ$



Vector Addition Using Components

A bee flies for 30m in a direction that is 20° north of east. It then turns and flies for 20m in a direction that is 70° north of east.

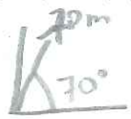
25) What is the X component of the first part of the journey?

$30\cos 20° = \boxed{28.2\text{m}}$

26) What is the Y component of the first part of the journey?

$30\sin 20° = \boxed{10.3\text{m}}$

27) What is the X component of the second part of the journey?



$20\cos 70° = \boxed{6.8\text{m}}$

28) What is the Y component of the second part of the journey?

$20\sin 70 = \boxed{18.8\text{m}}$

29) What is the X component of the total journey?

$28.2\text{m} + 6.8\text{m} = \boxed{35.0\text{m}}$

30) What is the Y component of the total journey?

$10.3 + 18.8 = \boxed{29.1\text{m}}$

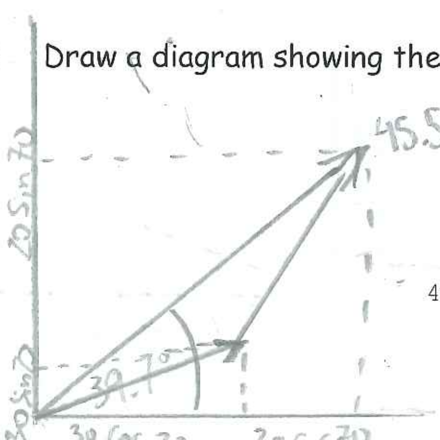
31) What is the magnitude of the displacement of the bee as a result of this total journey?

$mag = \sqrt{(35.0)^2 + (29.1)^2} = \boxed{mag = 45.5\text{m}}$

32) In what direction (relative to east) is the bee at the end of the journey?

$45.5\cos\theta = 35.0\text{m} \quad \theta = \cos^{-1}\left(\frac{35.0}{45.5}\right) \quad \boxed{\theta = 39.7°}$

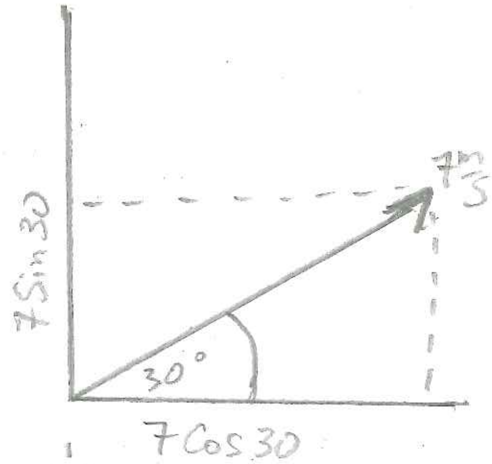
33) Draw a diagram showing the vector components and the true velocity vector.



"ijk" Vector Notation

A football has been kicked at 7 m/s along a line that has a 30 degree angle of elevation.

34) Draw a vector diagram of this.



35) What is the X component of this vector?

$7\cos 30 = \boxed{(6.1\,\hat{i})\frac{m}{s}}$

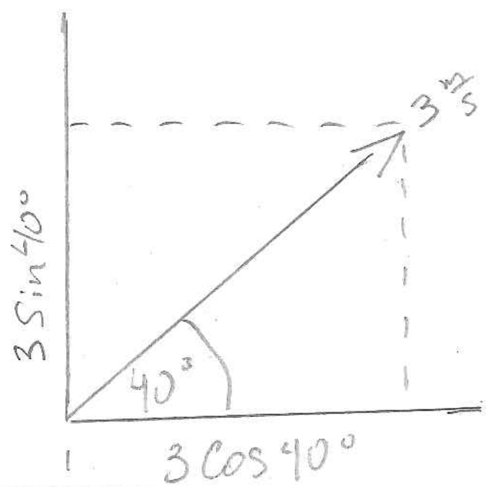
36) What is the Y component of this vector?

$7\sin 30 = \boxed{(3.5\,\hat{j})\frac{m}{s}}$

37) Write this in 'ijk' notation. $\boxed{(6.1\hat{i} + 3.5\hat{j} + 0.0\hat{k})\frac{m}{s}}$

A football has been kicked at 3 m/s along a line that has a 40 degree angle of elevation.

38) Draw a vector diagram of this.



39) What is the X component of this vector?

$3\cos 40 = \boxed{2.3\ \frac{m}{s}}$

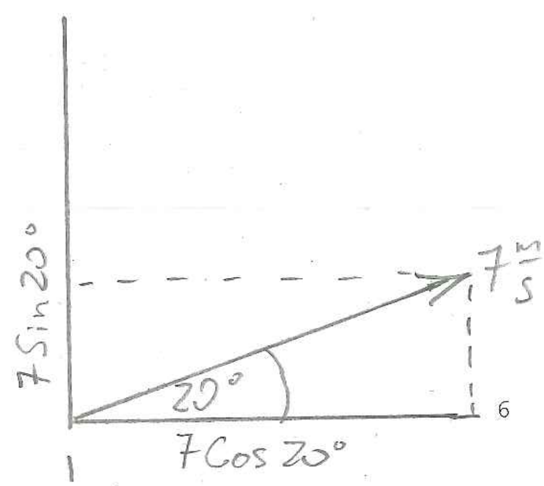
40) What is the Y component of this vector?

$3\sin 40 = \boxed{1.9\ \frac{m}{s}}$

41) Write this in 'ijk' notation. $\boxed{(2.3\hat{i} + 1.9\hat{j} + 0.0\hat{k})\frac{m}{s}}$

A football has been kicked at 7 m/s along a line that has a 20 degree angle of elevation.

42) Draw a vector diagram of this.



43) What is the X component of this vector?

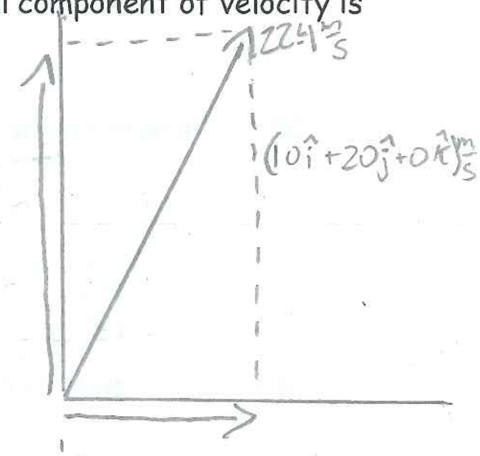
$7\cos 20° = \boxed{6.6\ \frac{m}{s}}$

44) What is the Y component of this vector?

$7\sin 20° = \boxed{2.4\ \frac{m}{s}}$

45) Write this in 'ijk' notation. $\boxed{(6.6\hat{i} + 2.4\hat{j} + 0.0\hat{k})\frac{m}{s}}$

A football's horizontal component of velocity is +10 m/s and its vertical component of velocity is +20 m/s.



46) Express the horizontal component as an 'ijk' vector.

$\boxed{(10\hat{i} + 0\hat{j} + 0\hat{k})\frac{m}{s}}$

47) Express the vertical component as an 'ijk' vector.

$\boxed{(0\hat{i} + 20\hat{j} + 0\hat{k})\frac{m}{s}}$

48) Express the vector as an 'ijk' vector.

$\boxed{(10\hat{i} + 20\hat{j} + 0\hat{k})\frac{m}{s}}$

49) Determine the speed of the football (the magnitude of the vector).

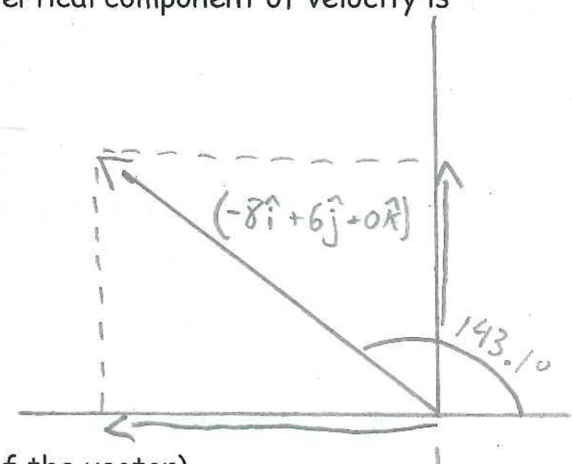
$mag = \sqrt{10\hat{i}^2 + 20\hat{j}^2 + 0\hat{k}^2}$ $\boxed{mag = 22.4\frac{m}{s}}$

50) Determine the direction of the football relative to the positive x axis.

$22.4\cos\theta = 10$ $\theta = \cos^{-1}\left(\frac{10}{22.4}\right)$ $\boxed{\theta = 63.5^\circ}$

51) Draw a diagram showing the vector.

A football's horizontal component of velocity is -8 m/s and its vertical component of velocity is +6 m/s.



52) Express the horizontal component as an 'ijk' vector.

$\boxed{(-8\hat{i} + 0\hat{j} + 0\hat{k})\frac{m}{s}}$

53) Express the vertical component as an 'ijk' vector.

$\boxed{(0\hat{i} + 6\hat{j} + 0\hat{k})\frac{m}{s}}$

54) Express the vector as an 'ijk' vector.

$\boxed{(-8\hat{i} + 6\hat{j} + 0\hat{k})\frac{m}{s}}$

55) Determine the speed of the football (the magnitude of the vector).

$mag = \sqrt{(-8)^2 + 6^2} =$ $\boxed{mag = 10\frac{m}{s}}$

?

56) Determine the direction of the football relative to the positive x axis.

$-10\cos\theta = 8 \rightarrow -\theta = \cos^{-1}\left(\frac{8}{10}\right)$

57) Draw a diagram showing the vector. $\theta = -36.87^\circ$

$\theta = 180 - 36.87^\circ$

$\boxed{\theta = 143.13^\circ}$?

Vector Arithmetic Using 'ijk' Vector Notation (3D vectors)

Given that A=(3i+4j+5k)m B=(2i-2j-3k)m C=(-2i-1j-2k)m

58) Determine A+B+C

i	j	k
3	4	5
2	-2	-3
-2	-1	-2
3i	1j	0k

$\boxed{(3\hat{i}+1\hat{j}+0\hat{k})}$

59) Determine the magnitude of A+B+C

$mag = \sqrt{3^2+1^2+0^2}$

$\boxed{mag = 3.2}$

60) Determine A+2B

i	j	k
3	4	5
4	-4	-6
7i	0j	-1k

$\boxed{(7\hat{i}+0\hat{j}-1\hat{k})m}$

61) Determine the magnitude of A+2B

$mag = \sqrt{7^2+0^2+(-1)^2}$

$\boxed{mag = 7.1m}$

62) Determine C-A

i	j	k
-2	-1	-2
-3	-4	-5
-5i	-5j	-7k

$\boxed{(-5\hat{i}-5\hat{j}-7\hat{k})m}$

63) Determine the magnitude of C-A

$mag \sqrt{(-5)^2+(-5)^2+(-7)^2}$

$\boxed{mag = 9.9m}$

64) Determine A-2B

i	j	k
3	4	5
-4	+4	+6
-1i	8j	11k

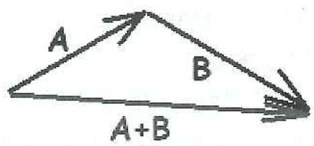
$\boxed{(-1\hat{i}+8\hat{j}+11\hat{k})m}$

65) Determine the magnitude of A-2B

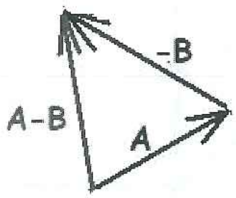
$mag = \sqrt{(-1)^2+8^2+11^2} =$ $\boxed{mag = 13.6m}$

Chapter 3 Answers

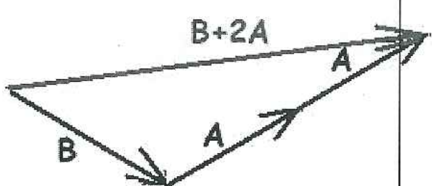
1)



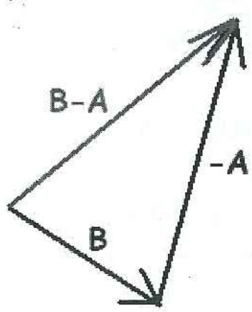
2)



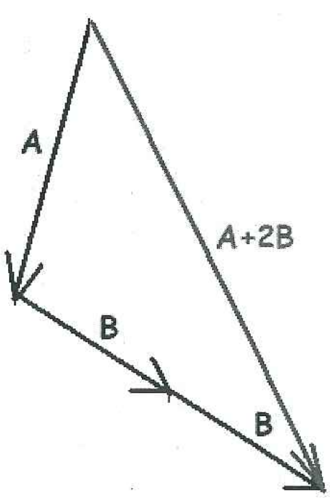
3)



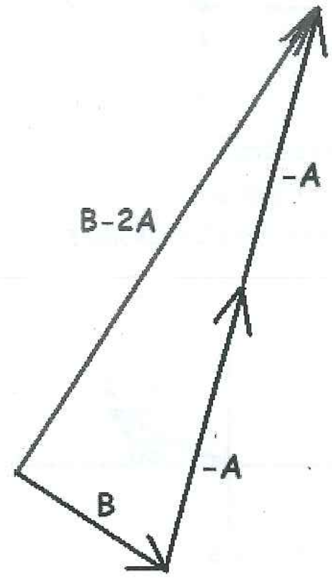
4)



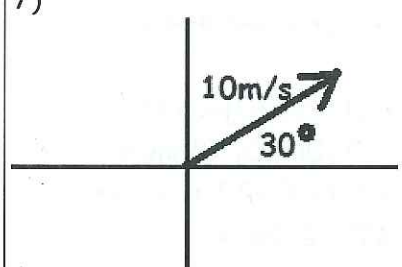
5)



6)

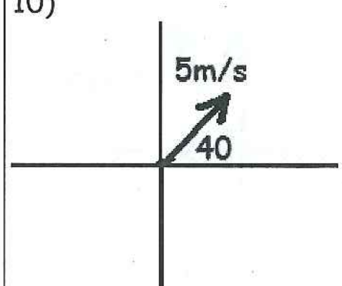


7)



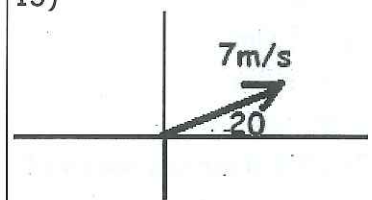
8) +8.7m/s
9) +5.0m/s

10)



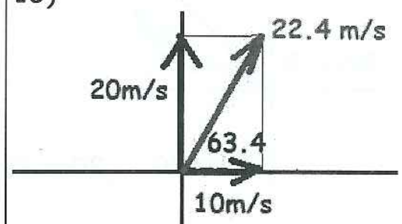
11) +3.8m/s
12) +3.2m/s

13)



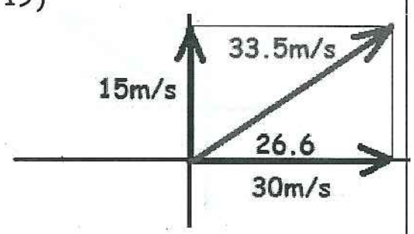
14) +6.6m/s
15) +2.4m/s

16)



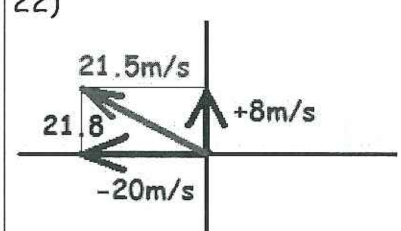
17) 22m/s
18) 63.4 degrees

19)



20) 33.5m/s
21) 26.6 degrees

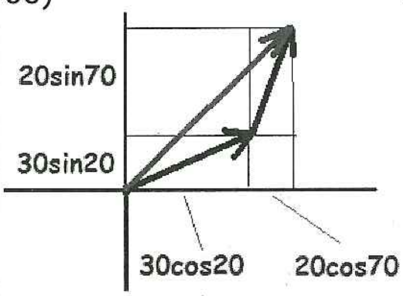
22)



23) 21.5m/s
24) 158.2 degrees

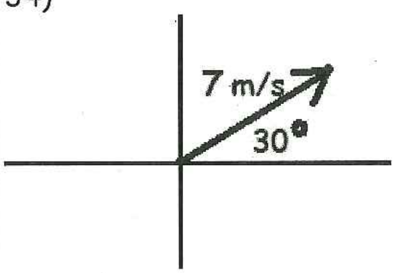
Vector Addition using Components
25) +28.2m

26) +10.4m
27) +6.8m
28) +18.8m
29) +35.0m
30) +29.2m
31) 45.6m
32) 39.8 degrees north of east
33)



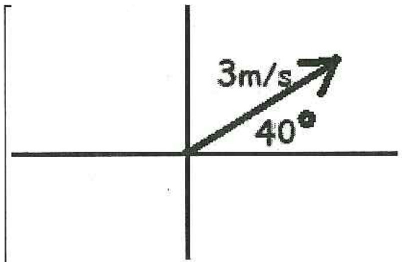
<u>'ijk' Vector Notation</u>

34)



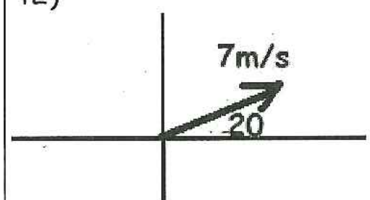
35) +6.1m/s
36) +3.5m/s
37) (+6.1i+3.5j+0k)m/s

38)



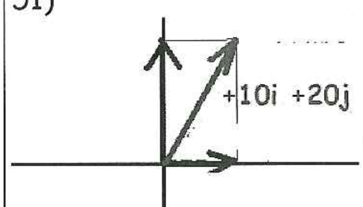
39) +2.3m/s
40) +1.9m/s
41) (+2.3i+1.9j+0k)m/s

42)

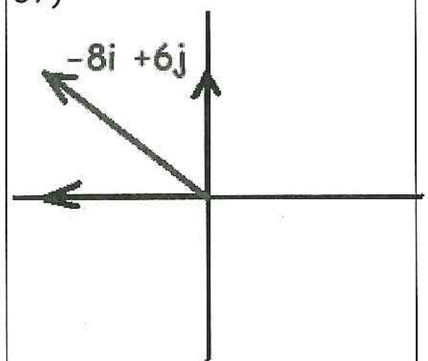


43) +6.6m/s
44) +2.4m/s
45) (+6.6i+2.4j+0k)m/s

46) (+10i+0j+0k)m/s
47) (0i+20j+0k)m/s
48) (+10i+20j+0k)m/s
49) 22.4m/s
50) 63.4 degrees angle of elevation to the positive X axis.
51)



52) (-8i+0j+0k)m/s
53) (0i+6j+0k)m/s
54) (-8i+6j+0k)m/s
55) 10.0m/s
56) 148.1 degrees angle of elevation to positive X axis.
57)



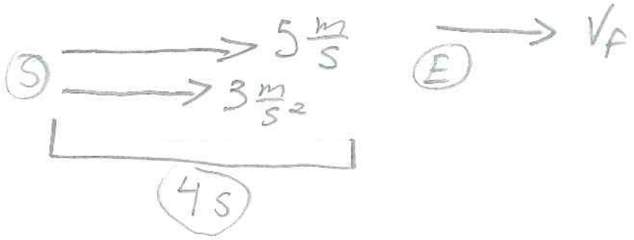
<u>3f) Vector Arithmetic Using 'ijk' Vector Notation (3D vectors)</u>

58) (+3i+1j+0k)m
59) 3.2m
60) (+7i+0j-1k)m
61) 7.1m
62) (-5i-5j-7k)m
63) 9.9m
64) (-1i+8j+11k)m
65) 13.6m

1-D Motion Part 2 Homework

Kinematic Equations

1) A particle had an initial velocity of +5m/s and a constant acceleration of +3m/s^2 throughout its journey. Its journey lasts 4s. What is its final velocity?



$V_i = 5\frac{m}{s}$

$a = 3\frac{m}{s^2}$

$\Delta T = 4s$

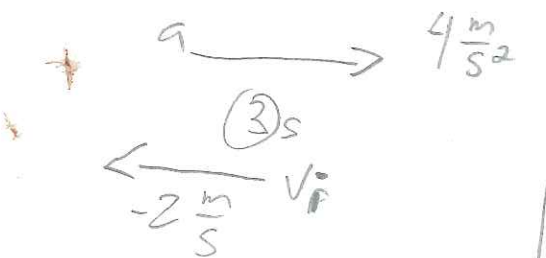
$V_f = V_i + a\Delta T$

$V_f = 5 + 3(4)$

$V_f = 5 + 12$

$\boxed{V_f = 17\frac{m}{s}}$

2) A particle has a constant acceleration of +4m/s^2 throughout its journey. The journey lasts for 3s. The particle's initial velocity is -2m/s. What is the particles displacement resulting from this journey?



$\Delta X = ?$

$V_i = -2\frac{m}{s}$

$\Delta T = 3s$

$a = 4\frac{m}{s^2}$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2}a\Delta T^2$

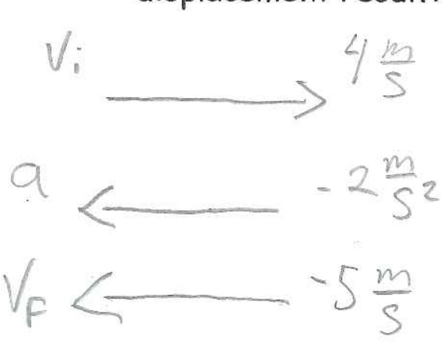
$\Delta X = (-2)(3) + \frac{1}{2}(4)(3^2)$

$\Delta X = -6 + 2(9)$

$\Delta X = -6 + 18$

$\boxed{\Delta = 12m}$

3) A particle had an initial velocity of +4m/s and a constant acceleration of -2m/s^2 throughout its journey. Its final velocity was -5m/s. What is the particles displacement resulting from this journey?



$a = \frac{V_f - V_i}{\Delta T}$

$\Delta T = \frac{\Delta V}{a} = \frac{-5\frac{m}{s} - 4\frac{m}{s}}{-2\frac{m}{s^2}} = +\frac{9}{2}s = \boxed{4.5s}$

$\Delta X = ?$

$V_i = 4\frac{m}{s}$

$V_f = -5\frac{m}{s}$

$a = -2\frac{m}{s^2}$

$\Delta T = 4.5s$

$\Delta X = \frac{1}{2}(V_f + V_i)\Delta T$

$\Delta X = \frac{1}{2}(-5+4)(4.5)$

$\Delta X = \frac{1}{2}(-1)(4.5)$

$\Delta X = \frac{1}{2}(-\frac{9}{2})$

$\boxed{\Delta X = -2.25m}$

4) A particle has an initial velocity of -6m/s. It has a final velocity of +2m/s. Its journey was at constant acceleration and lasted 3s. What displacement resulted from this journey?

$V_i \longleftarrow -6\frac{m}{s}$

$V_f \longrightarrow 2\frac{m}{s}$

$\Delta T = 3s$

$\bar{a} = \frac{\Delta V}{\Delta T} = \frac{2-(-6)}{3} = \frac{8}{3}\frac{m}{s^2}$

$\bar{a} = 2.67\frac{m}{s^2}$

$\Delta X = ?$

$\Delta X = \frac{1}{2}(V_f + V_i)\Delta T$

$\Delta X = \frac{1}{2}(2-6)(3) = \frac{1}{2}(-4)(3) = \frac{-12}{2} = \boxed{-6m}$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2}a \cdot \Delta T^2$

$\Delta X = (-6)(3) + \frac{1}{2}(2.67)(9)$

$\Delta X = -18 + \frac{1}{2}(24.03)$

$\Delta X = -18 + 24.03$ $\boxed{\Delta X = -6m}$

5) A particle had an initial velocity of +4m/s and a constant acceleration of -3m/s^2 throughout its journey. Its final velocity is -2m/s. How long did the journey last?

$V_i \longrightarrow 4\frac{m}{s}$

$a \longleftarrow -3\frac{m}{s^2}$

$V_f \longleftarrow -2\frac{m}{s}$

$\bar{a} = \frac{\Delta V}{\Delta T} \rightarrow \Delta T = \frac{\Delta V}{\bar{a}} \rightarrow \frac{-2-4}{-3} = \boxed{2s}$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2}a \cdot \Delta T^2$

$\Delta X = 4 \cdot 2 + \frac{1}{2}(-3)(4) = 8 + \frac{1}{2}(-12) = 8 - 6 = \underline{\Delta X = 2m}$

$V_f = V_i + a\Delta T$

$\Delta T = \frac{V_f - V_i}{a}$ $V_f^2 = V_i^2 + 2a\Delta X$

6) A particle had an initial velocity of +8m/s and a constant acceleration of -2m/s^2 throughout its journey. Its journey causes a displacement of -6m. What is its final velocity?

$V_i \longrightarrow 8\frac{m}{s}$

$a \longleftarrow -2\frac{m}{s^2}$

$\Delta X \xleftarrow{-6m}$

$V_f^2 = V_i^2 + 2a\Delta X$

$V_f^2 = (8^2) + 2(-2)(-6)$

$V_f^2 = 64 + 2(12)$

$V_f^2 = 64 + 24 = 88$

$V_f = \sqrt{88}$ $\boxed{V_f = 9.4\frac{m}{s}}$

7) A particle has a final velocity of +3m/s. Its journey was at constant acceleration and lasted 5s. The journey causes a displacement of +6m. What was its initial velocity?

$V_F \longrightarrow 3\frac{m}{s}$

$\Delta T = 5s$

$\Delta X \xrightarrow{6m}$

$V_i = ?$

$\Delta X = \frac{1}{2}(V_F + V_i)\Delta T = \frac{2\Delta X}{\Delta T} = V_F + V_i = \frac{2\Delta X}{\Delta T} - V_F$

$V_i = \frac{2\Delta X}{\Delta T} - V_F = \frac{2(6)}{5} - 3 = \frac{12}{5} - \frac{15}{5} = \frac{-3}{5}$

$\boxed{V_i = -0.6\frac{m}{s}}$

8) A particle has a constant acceleration of +5m/s² throughout its journey. The particle's initial velocity is 0m/s. The particles displacement resulting from this journey is +9m. That was the duration of the journey?

$a \xrightarrow{5\frac{m}{s^2}}$

$V_i = 0\frac{m}{s}$

$\Delta X \xrightarrow{9m}$

$\Delta T = ?$

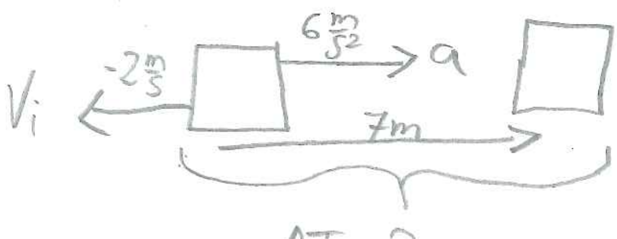
$V_F^2 = V_i^2 + 2a\Delta X$

$V_F^2 = 0^2 + 2(5)(9) = V_F^2 = 90 = \sqrt{90} = V_F = 9.5\frac{m}{s}$

$V_F = V_i + a\Delta T \rightarrow \Delta T = \frac{V_F - V_i}{a}$

$\Delta T = \frac{9.5 - 0}{5} = \frac{9.5}{5} = \boxed{1.9s}$ or $\frac{\sqrt{90}}{5} = \boxed{1.897s}$

9) A particle has a constant acceleration of +6m/s² throughout its journey. The particle's initial velocity is -2m/s. The particles displacement resulting from this journey is +7m. That was the duration of the journey?



$V_F^2 = V_i^2 + 2a\Delta X = (-2)^2 + 2(6)(7) = \sqrt{88}$

$\Delta T = \frac{V_F - V_i}{a}$ $\quad \Delta T = \frac{\sqrt{88}+2}{6} = \boxed{\Delta T = 1.897s}$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2}a \cdot \Delta T^2$

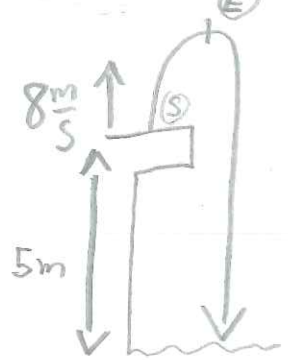
$7m = (-2)\Delta T + \frac{1}{2}(6)\Delta T^2$

$3T^2 - 2T - 7 = 0 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{2 \pm \sqrt{4 - 4(3)(-7)}}{6} = \frac{2 \pm \sqrt{88}}{6} = \boxed{1.897s}$

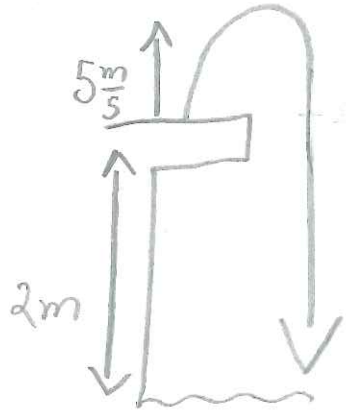
10) A diver jumps upwards off a diving board with a speed of 8m/s. The board is 5m above the water. What is the diver's acceleration when she is stationary at the top of her ark?

$a=?$



acceleration is constant during free fall $\boxed{a=-10\frac{m}{s^2}}$

11) A diver jumps upwards off a diving board with a speed of 5m/s. The board is 2m above the water. What is the diver's acceleration when she passes the board on her way downwards towards the water?

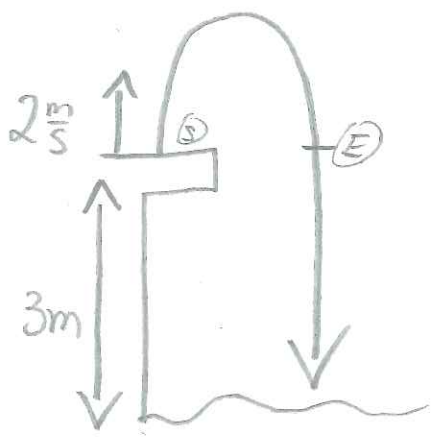


$a=?$

Acceleration is constant in free fall

$\boxed{a=-10\frac{m}{s^2}}$

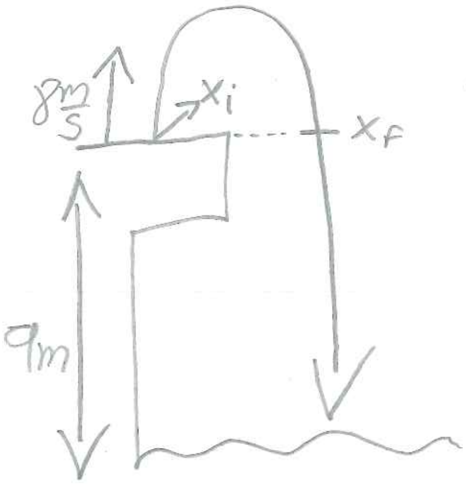
12) A diver jumps upwards off a diving board with a speed of 2m/s. The board is 3m above the water. What is the diver's velocity when she passes the board on her way downwards towards the water?



Speed is the same at points of the same height in free fall

$\boxed{V=-2\frac{m}{s}}$

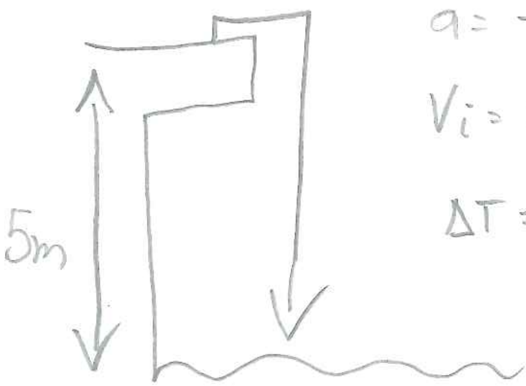
13) A diver jumps upwards off a diving board with a speed of 8m/s. The board is 9m above the water. What is the diver's displacement from the board when she passes the board on her way downwards towards the water?



$\Delta X = X_f - X_i \therefore \Delta X = X_i - X_i = \boxed{0m}$

$X_f = X_i$

14) A diver steps off of a diving board. The diving board is 5m above the water. How long does it take the diver to reach the water?



$\Delta X = -5m$

$a = -10 \frac{m}{s^2}$

$V_i = 0 \frac{m}{s}$

$\Delta T = ?$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2} a (\Delta T)^2$

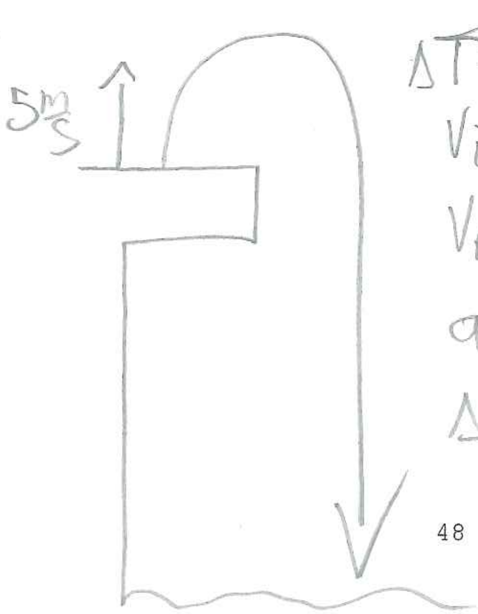
$-5 = 0(\Delta T) + \frac{1}{2}(-10)T^2$

$-5 = -5T^2$

$T^2 = 1$

$\boxed{\Delta T = 1s}$

15) A diver jumps up off of a diving board at +5m/s. The diver takes 4s to reach the water below the board. How high is the diving board above the water?



$\Delta T = 4s$

$V_i = 5 \frac{m}{s}$

$V_f = ?$

$a = -10 \frac{m}{s^2}$

$\Delta X = ?$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2} a \cdot \Delta T^2$

$V_f = V_i + a\Delta T$

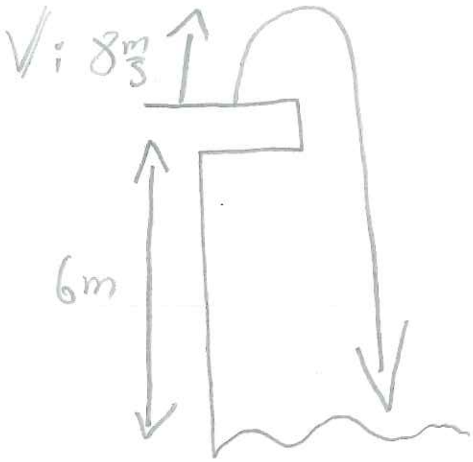
$\Delta X = 5 \cdot (4) + \frac{1}{2}(-10)(16)$

$\Delta X = 20 + (-80) = \boxed{\Delta X = -60m}$

$V_f = 5 + (-10)(4)$

$V_f = 5 + (-40) = \boxed{V_f = -35 \frac{m}{s}}$

16) A diver jumps upwards off of a diving board with a speed of 8m/s. The board is 6m above the water. What is the diver's speed as she reaches the water?



$V_i = 8\frac{m}{s}$

$a = -10\frac{m}{s^2}$

$\Delta X = -6m$

$V_f^2 = V_i^2 + 2a\Delta X$

$V_f^2 = (8)^2 + 2(-10)(-6m)$

$V_f^2 = 64 + (120)$

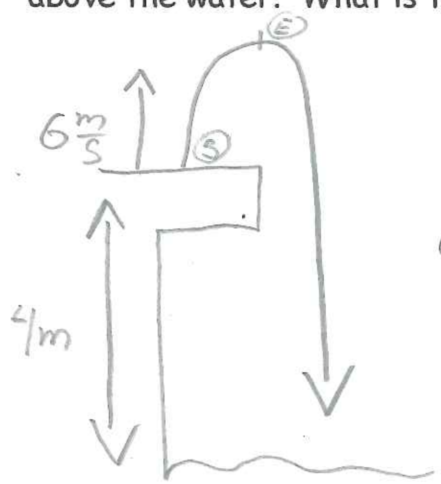
$V_f = \sqrt{184}$

$V_f = \pm 13.56$

$\boxed{V_f = -13.56}$

$a = \frac{\Delta V}{\Delta T}$

17) A diver jumps upwards off of a diving board with a speed of 6m/s. The board is 4m above the water. What is the diver's maximum height above the water?



$V_i = 6\frac{m}{s}$

$V_f = 0\frac{m}{s}$

$a = -10\frac{m}{s^2}$

$\Delta X = \frac{1}{2}(V_f + V_i)\Delta T$

$X_f - X_i = \frac{1}{2}(0+6)(.6)$

$X_f = \frac{1}{2}(6)(.6) + 4$

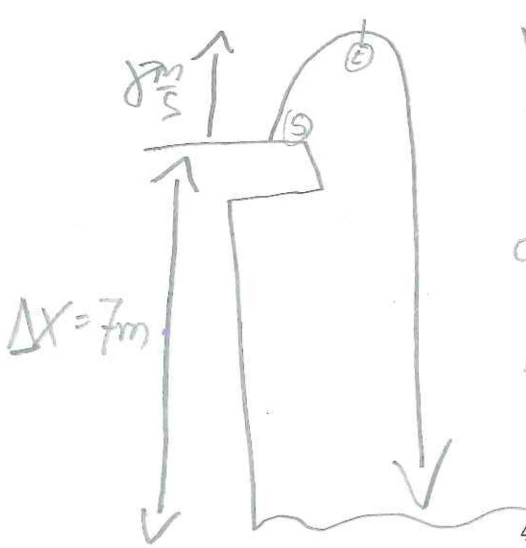
$\boxed{X_f = 5.8m}$

$\Delta T = \frac{\Delta V}{a} = \frac{0 - 6\frac{m}{s}}{-10\frac{m}{s^2}} = \underline{0.6s}$

$V_f = V_i + a\Delta t$

$0 = (+6) + (-10)(\Delta t) =$

18) A diver jumps upwards off of a diving board with a speed of 8m/s. The board is 7m above the water. For what duration of time does the diver travel upwards?



$V_i = 8\frac{m}{s}$

$V_f = 0\frac{m}{s}$

$a = -10\frac{m}{s^2}$

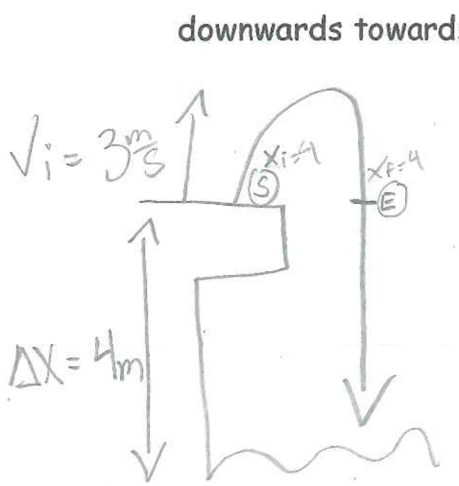
$\Delta X = 7m$

$\Delta T = ?$

$\Delta T = \frac{V_f - V_i}{a} = \frac{0 - 8\frac{m}{s}}{-10\frac{m}{s^2}} = \boxed{0.8s}$

other formulas don't work ?

19) A diver jumps upwards off of a diving board with a speed of 3m/s. The board is 4m above the water. How long does it take the diver to pass the board on her way downwards towards the water?



$\Delta T = ?$

$V_i = 3\frac{m}{s}$

$\Delta X = 0$

$a = -10\frac{m}{s^2}$

$V_f^2 = V_i^2 + 2a\Delta X \rightarrow V_f^2 = 9 + 2(-10)(0)$

$= V_f^2 = 9 - 0 \rightarrow V_f = \pm\sqrt{9} \rightarrow V_f = -3\frac{m}{s}$

$V_f = V_i + a\Delta T \rightarrow \Delta T = \frac{V_f - V_i}{a} \rightarrow \Delta T = \frac{-3-3}{-10}$

$\boxed{\Delta T = 0.6\frac{m}{s}}$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2}a\Delta T^2 \rightarrow 0 = 3\Delta T + \frac{1}{2}(-10)\Delta T^2$

$0 = 3T - 5T^2 = \frac{-3 \pm \sqrt{9-4(-5)}}{2(-5)} = \frac{-3 \pm \sqrt{29}}{-10} = \Delta T = -?$

$\Delta T = ?$

20) A basketball player jumps upward from a gym floor. Her hang-time (time in the air) is 6s. What was her initial velocity?

$\Delta T = 6s$

$\Delta x = 0$

$a = -10\frac{m}{s^2}$

$V_i = ?$

$\Delta X = V_i \cdot \Delta T + \frac{1}{2}a\Delta T^2 \rightarrow 0 = V_i(6) + \frac{1}{2}(-10)(6)^2$

$0 = 6V_i - 180 \rightarrow 6V_i = 180$

$V_i = \frac{180}{6} \rightarrow \boxed{V_i = 30\frac{m}{s}}$

21) A basketball player jumps upwards from a gym floor. Her hang-time is 4s. What was her maximum height above the floor?

$V_f = 0\frac{m}{s}$

$\Delta T = \frac{4s}{2}$

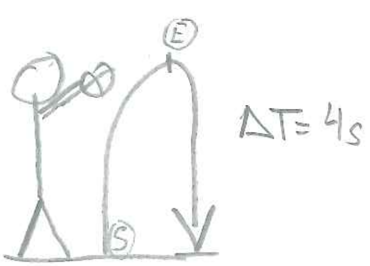
$a = -10\frac{m}{s^2}$

$a = \frac{\Delta V}{\Delta T} \rightarrow \Delta V = a \cdot \Delta T \rightarrow V_f - V_i = a \cdot \Delta T$

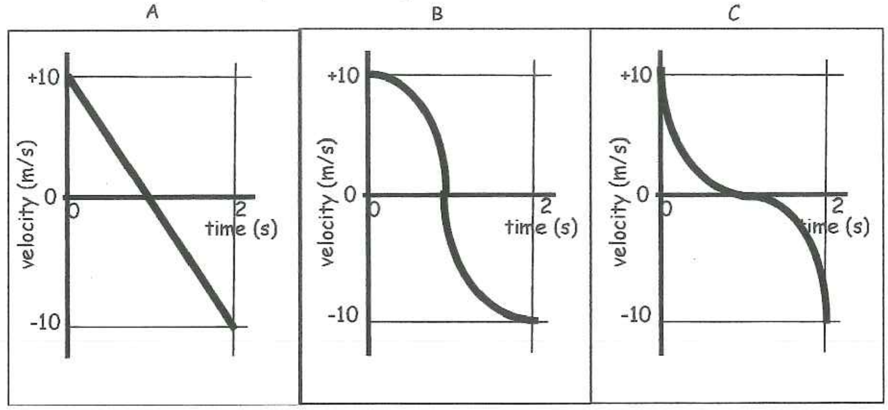
$0 - V_i = (-10)(\frac{4}{2}) \rightarrow -V_i = -20 \rightarrow V_i = 20\frac{m}{s}$

$\Delta X = \frac{1}{2}(V_f + V_i) \cdot \Delta T \rightarrow \Delta X = \frac{1}{2}(0+20)(\frac{4}{2})$

$\Delta X = \frac{40}{2} \rightarrow \boxed{\Delta X = 20m}$



22) A tennis player throws a ball upwards with a speed of 10m/s. Which graph best represents the balls velocity as time passes?



Acceleration is constant In a negative direction.

$\therefore$ A

23) An astronaut is on the surface of an asteroid. She jumps upwards with a speed of 6m/s. Her hang-time is 40s. What is the acceleration caused by gravity?

$V_i = 6\frac{m}{s}$

$\Delta T = 40s$

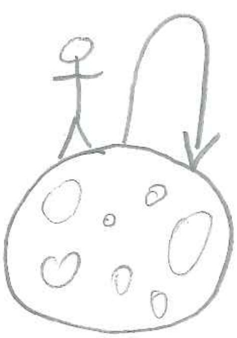
$a = ?$

$V_f = -6\frac{m}{s}$

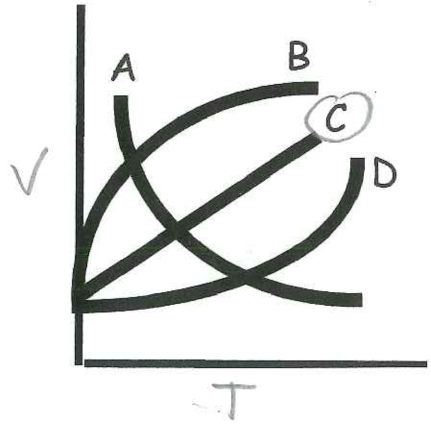
$$\bar{a} = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{\Delta T} = \frac{-6\frac{m}{s} - 6\frac{m}{s}}{40s} = \boxed{\bar{a} = -0.3\frac{m}{s^2}}$$

$$V_f = V_i + a\Delta T \rightarrow 0 = 6 + a(20s)$$

$$\frac{-6\frac{m}{s}}{20s} = a \rightarrow \bar{a} = -0.3\frac{m}{s^2}$$



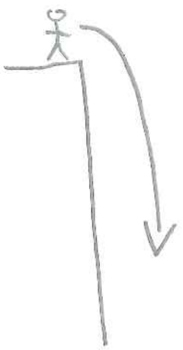
24) A car is travelling in a positive direction along a straight and level road. At a certain time the car starts to move with a constant positive acceleration. Which trace best represents the resulting velocity versus time graph for the constant acceleration part of the journey?



Constant positive acceleration

$\therefore$ C

25) In the movie "Superman II", a small child falls over Niagara Falls. The film shows that the child falls for 30 seconds before Superman catches him. How far does the child fall during this time?



$v_i = 0\frac{m}{s}$

$a = -10\frac{m}{s^2}$

$\Delta T = 30s$

$\Delta X = ?$

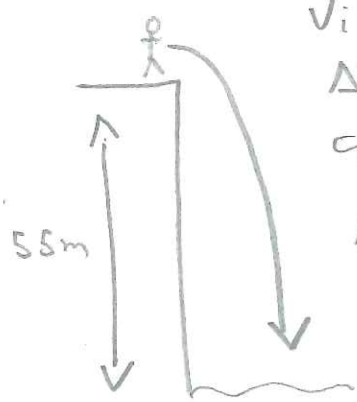
$\Delta X = V_i \cdot \Delta T + \frac{1}{2} a \Delta T^2$

$\Delta X = 0(30) + \frac{1}{2}(-10)(30^2)$

$\Delta X = (-5)(900)$

$\boxed{\Delta X = -4500m}$

26) In reality, Niagara Falls is 55 m tall. In the movie "Superman II" a small child falls over the falls. How long would Superman have to catch the child before he reached the water?



$v_i = 0\frac{m}{s}$

$\Delta X = 55m$

$a = -10\frac{m}{s^2}$

$\Delta T = ?$

$V_f^2 = V_i^2 + 2a\Delta X \rightarrow V_f^2 = 0^2 - 2(-10)(-55m)$

$V_f^2 = +1100 \rightarrow V_f = \pm\sqrt{1100} \rightarrow V_f = 33.166$

$\Delta X = \frac{1}{2}(V_f + V_i)\Delta T \rightarrow \frac{2\Delta X}{V_f + V_i} = \Delta T$

$\Delta T = \frac{2(-55)}{-\sqrt{1100} + 0} = \frac{-110}{-\sqrt{1100}} = \boxed{\Delta T = 3.32s}$

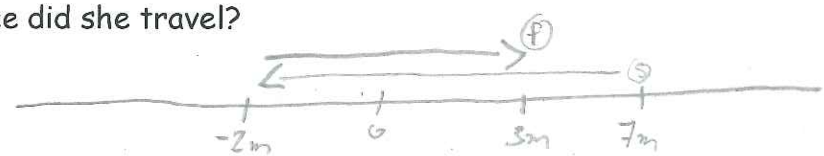
Constant Acceleration Answers

1) +17m/s
2) +12m
3) -2.25m
4) -6.0m
5) 2.0s
6) -9.4m/s
7) -0.6m/s
8) 1.90s
9) 1.90s
10) $-10 m/s^2$
11) $-10 m/s^2$
12) -2m/s
13) 0m
14) 1s
15) -60m
16) -13.6m/s
17) 5.8m
18) 0.8s
19) +0.6s
20) +30m/s
21) +20m
22) A
23) $-0.3 m/s^2$
24) C
25) -4500m
26) 3.32s

<u>1-D Motion Part 1 Homework</u>

Displacement and Distance travelled

1) A runner starts at a coordinate of +7 m. She runs to coordinate -2m. She then runs to coordinate +3 m. What is her displacement as a result of this journey and what distance did she travel?

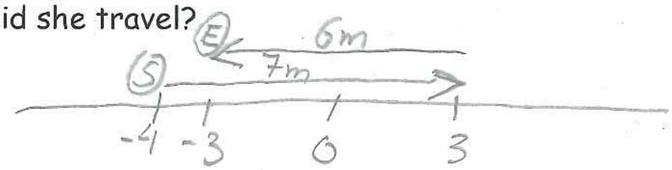


Displacement:

$\Delta X = X_f - X_s = 3m - 7m$ $\boxed{\Delta X = -4m}$

$DT = 9 + 5$ $\boxed{DT = 14m}$

2) A runner starts at a coordinate of -4 m. She runs 7m to the right. She then runs to coordinate -3m. What is her displacement as a result of this journey and what distance did she travel?



$\Delta X = X_f - X_i = -3 - (-4) = \boxed{1m}$

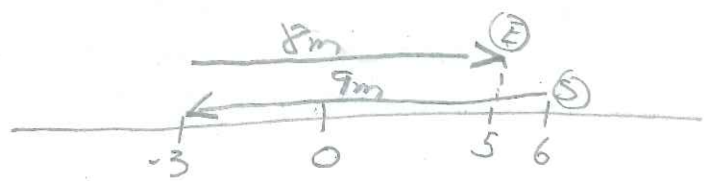
$DT = 7m + 6m = \boxed{13m}$

3) A runner starts at a coordinate of +6 m. She runs to coordinate -3 m. She then runs to coordinate +5 m. What is her displacement as a result of this journey and what distance did she travel?

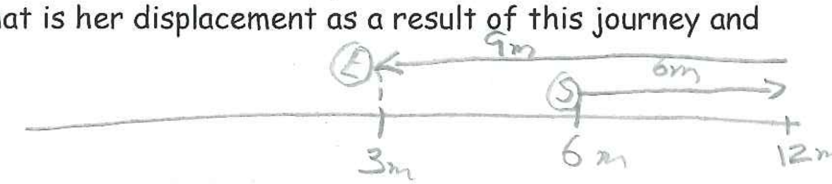
$\Delta X = X_f - X_i$

$\Delta X = 5 - 6 = \boxed{-1m}$

$DT = 9m + 8m = \boxed{17m}$



4) A runner starts at a coordinate of +6 m. She runs to the right at 2m/s for 3 seconds. She then runs 9m to the left. What is her displacement as a result of this journey and what distance did she travel?



$\vec{V} = \frac{\Delta X}{\Delta T} = \vec{V} \cdot \Delta T = \Delta X$

$2\frac{m}{s} \cdot 3s = 6m$

$\Delta X = X_f - X_i$

$\Delta X = 3m - 6m = \boxed{-3m}$

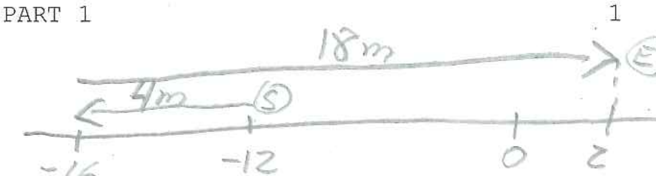
$DT = 6m + 9m = \boxed{15m}$

5) A runner starts at a coordinate of -12 m. She runs 4m to the left. She then runs to coordinate +2 m. What is her displacement as a result of this journey and what distance did she travel?

$\Delta X = X_f - X_i = 2 - (-12) = \boxed{14m}$

$DT = 4m + 18m$

$\boxed{DT = 22m}$



Average Velocity and Speed

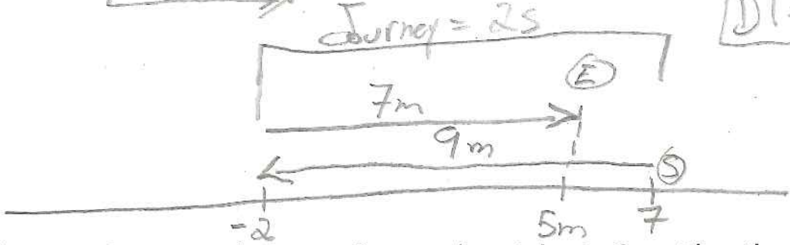
6) A runner starts at a coordinate of +7 m. She runs to coordinate -2m. She then runs to coordinate +5 m. Her journey takes 2 s. What is her average velocity during this journey and what is her average speed?

$\bar{V} = \frac{\Delta x}{\Delta t} = x_f - x_i = 5m - 7m = \boxed{\Delta x = -2m}$

$DT = 9m + 7m$ $\boxed{DT = 16m}$

$\bar{V} = \frac{-2m}{2s} = \boxed{-1 \frac{m}{s}}$

$\bar{S} = \frac{DT}{\Delta T} = \frac{16m}{2s} = \boxed{8 \frac{m}{s}}$

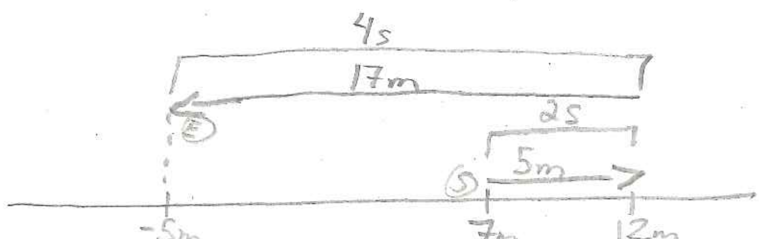


7) A runner starts at a coordinate of +7 m. She runs 5m to the right in 2s. She then runs to coordinate -5 m taking another 4s. What is her average velocity during this journey and what is her average speed?

$\boxed{DT = 22m}$

$\bar{V} = \frac{\Delta x}{\Delta T} = \frac{-5 - 7}{6s - 0} = \frac{-12m}{6s} = \boxed{-2 \frac{m}{s}}$

$\overline{Speed} = \frac{DT}{\Delta T} = \frac{22m}{6s} = \boxed{3.66 \frac{m}{s}}$



8) A runner starts at a coordinate of +8m. She runs to the left at 3m/s for 4seconds. She them is stationary for 2s. Finally she runs at 3m/s to the right for 6 seconds. What is her average velocity during this journey and what is her average speed?

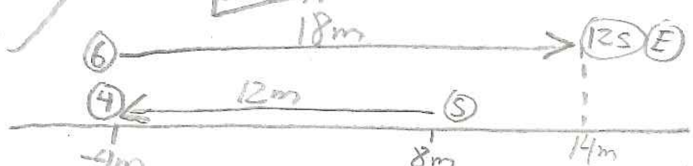
$\bar{V} = \frac{\Delta x}{\Delta T} = \Delta x = \Delta T \cdot \bar{V} = 4s(-3\frac{m}{s}) = -12m$

$DT = 12m + 18m = 30m$

$\bar{V} = \frac{\Delta x}{\Delta T} \quad \Delta x = \Delta T \cdot \bar{V} = 6s \cdot (3\frac{m}{s}) = 18m$

$\overline{Speed} = \frac{DT}{\Delta T} = \frac{30m}{12s} = \boxed{2.5 \frac{m}{s}}$

$\bar{V} = \frac{\Delta x}{\Delta T} = \frac{x_f - x_i}{T_f - T_i} = \frac{14m - 8m}{12s - 0s} = \frac{6m}{12s}$ $\boxed{\frac{1}{2} \frac{m}{s}}$



9) A runner starts at a coordinate of -9m. She runs to the right at 3m/s for 2s. She then runs to the left for 4 seconds at twice the speed she had on stage one. What is her average velocity during this journey and what is her average speed?

$\Delta x = \Delta T \cdot \bar{V} = 2s \cdot 3\frac{m}{s} = \boxed{\Delta x = 6m}$

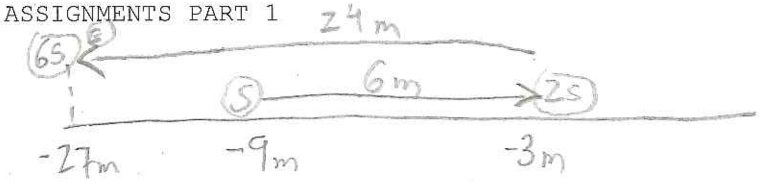
$\Delta x_2 = \Delta T \cdot \bar{V} = 4s \cdot 2(-3\frac{m}{s}) = 4s \cdot (-6\frac{m}{s})$

$\Delta x_2 = -24m$

$\bar{V} = \frac{\Delta x}{\Delta T} = \frac{x_f - x_i}{T_f - T_i} = \frac{-27m - (-9m)}{6s - 0s} = \frac{-18m}{6s} = \boxed{-3 \frac{m}{s}}$

$DT = 6m + 24m = 30m$

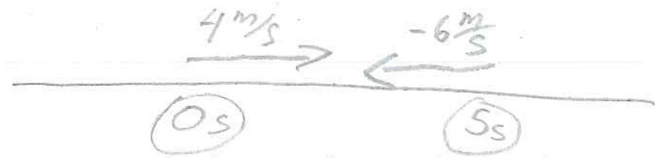
$\overline{Speed} = \frac{DT}{\Delta T} = \frac{30m}{6s} = \boxed{5 \frac{m}{s}}$



Average Acceleration

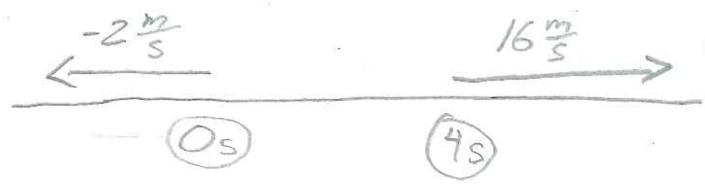
10) A runner starts with a velocity of +4 m/s. She ends with a velocity of -6 m/s. Her journey takes 5 s. What is her average acceleration during this journey?

$$\bar{a} = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{T_f - T_i} = \frac{-6\frac{m}{s} - 4\frac{m}{s}}{5s - 0s} = \frac{-10\frac{m}{s}}{5s} = \boxed{-2\frac{m}{s^2}}$$



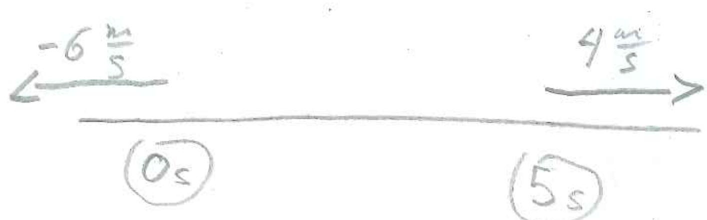
11) A runner has a velocity of -2 m/s at t=0s. She has a velocity of +16 m/s at t=4s. What is her average acceleration during this journey?

$$\bar{a} = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{T_f - T_i} = \frac{16\frac{m}{s} - (-2\frac{m}{s})}{4s - 0s} = \frac{18\frac{m}{s}}{4s} = \boxed{4.5\frac{m}{s^2}}$$



12) A runner has an initial velocity of -6 m/s. She has a final velocity of +4 m/s. Her journey takes 5s. What is her average acceleration during this journey?

$$\bar{a} = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{T_f - T_i} = \frac{4\frac{m}{s} - (-6\frac{m}{s})}{5s - 0s} = \frac{10\frac{m}{s}}{5s} = \boxed{2\frac{m}{s^2}}$$



Instantaneous position, Velocity and acceleration Using Calculus

13) A particle has a position versus time relationship given by y=3t-7. What is (a) the coordinate, (b) the instantaneous velocity, and (c), the instantaneous acceleration of the particle at t=3s?

a) $y=3t-7$ at $t=3s \rightarrow y=3(3)-7=\boxed{2m}$

b) $\frac{dy}{dt}=\boxed{3\frac{m}{s}}$

c) $\frac{d^2y}{dt^2}=\boxed{0\frac{m}{s^2}}$

14) A particle has a position versus time relationship given by y=4t^2-9. What is (a) the coordinate, (b) the instantaneous velocity, and (c), the instantaneous acceleration of the particle at t=2s?

a) $y=4t^2-9$ at $t=2s \Rightarrow y=4(2)^2-9=16-9 \Rightarrow \boxed{y(2)=7m}$

b) $\frac{dy}{dt}=8t=8(2)=\boxed{16\frac{m}{s}}$

c) $\frac{d^2y}{dt^2}=\boxed{8\frac{m}{s^2}}$

15) A particle has a position versus time relationship given by y=2t^2-4t+3. What is (a) the coordinate, (b) the instantaneous velocity, and (c), the instantaneous acceleration of the particle at t=5s?

a) $y(5)=2t^2-4t+3 \rightarrow 2(5)^2-4(5)+3=\boxed{y(5)=33m}$

b) $\frac{dy}{dt}=4t-4=4(5)-4=\boxed{16\frac{m}{s}}$

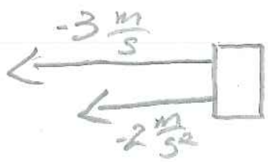
c) $\frac{d^2y}{dt^2}=\boxed{4\frac{m}{s^2}}$

Speeding Up or Slowing Down

16) A runner has a velocity of +4m/s and an acceleration of +5m/s^2. Is she travelling in a positive (right) or negative (left) direction and is she speeding up or slowing down?

Traveling in a positive direction & Speeding up

17) A runner has a velocity of -3m/s and an acceleration of -2m/s^2. Is she travelling in a positive (right) or negative (left) direction and is she speeding up or slowing down?



Traveling in a negative direction & Speeding up

18) A runner has a velocity of +2m/s and an acceleration of -3m/s^2. Is she travelling in a positive (right) or negative (left) direction and is she speeding up or slowing down?

Traveling in a positive direction but slowing down

Interpreting Kinematic Graphs

19) What physical significance is the slope of a 'velocity versus time' graph?

$\frac{Vel}{Time} = \frac{\frac{m}{s}}{s} = \frac{m}{s} \cdot \frac{1}{s} = \frac{m}{s^2}$

Slope is acceleration

20) What physical significance is the slope of a 'displacement versus time' graph?

$\frac{\Delta X}{T} = \frac{m}{s}$

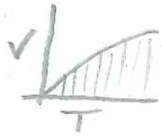
Slope is Velocity

21) What physical significance is the slope of an 'acceleration versus time' graph?

$\frac{a}{T} = \frac{\frac{m}{s^2}}{s} = \frac{m}{s^2} \cdot \frac{1}{s} = \frac{m}{s^3}$

Slope is Jerk

22) What physical significance is the area under the trace of a 'velocity versus time' graph?



$V \cdot T = \frac{m}{s} \cdot s = m$

Area is displacement

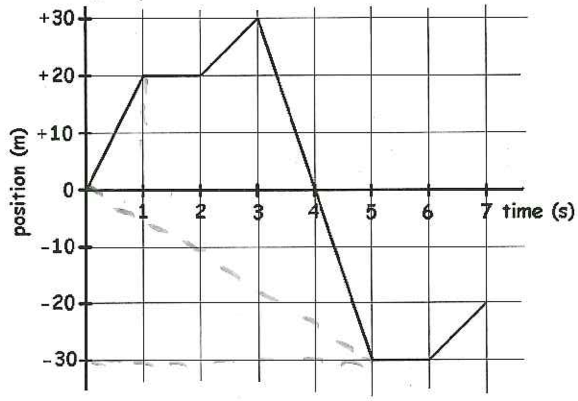
23) What physical significance is the area under the trace of an 'acceleration versus time' graph?

$a \cdot T = \frac{m}{s^2} \cdot s = \frac{m}{s}$

Area is Velocity

Motion Graphs – Position versus Time

Consider this position versus time graph:



24) What is the position of the particle at t=3s?

position = $\boxed{30m}$

25) What is the position of the particle at t=5s?

$\boxed{-30m}$

26) What is the average velocity of the particle between t=0s and t=1s?

$\bar{V} = \frac{\Delta x}{\Delta T} = \frac{X_f - X_i}{T_f - T_i} = \frac{20m - 0}{1s - 0} = \boxed{20 \frac{m}{s}}$

27) What is the average velocity of the particle between t=0s and t=5s?

$\bar{V} = \frac{\Delta x}{\Delta T} = \frac{-30m}{5s} = \boxed{-6 \frac{m}{s}}$

28) Is the particle moving in a positive direction, moving in a negative direction or standing still (stationary) at t=0.5s?

positive direction

29) Is the particle moving in a positive direction, moving in a negative direction or standing still (stationary) at t=1.5s?

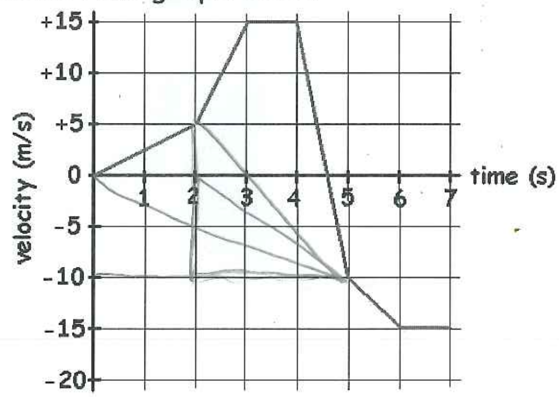
Slope is zero, so velocity is zero. particle is standing still

30) When (after the start) does the particle first return to the starting point?

at T=4s

Motion Graphs – Velocity versus Time

Consider this velocity versus time graph below



?

31) When does the object first start travelling in a negative direction?

turns at Velocity $=0$, 3 out of 5 blocks down $\frac{3}{5}=.6$

$\boxed{\text{at } 4.66}$

32) What is the velocity of the particle at time t=5.5s?

Velocity at $t=5.5$ is $\frac{1}{2}(10+15) = \boxed{12.5}$

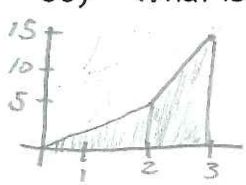
33) What is the average acceleration of the particle between time t=0s and t=5s?

$$\bar{a} = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{T_f - T_i} = \frac{-10-0}{5s - 0s} = \frac{-10\frac{m}{s}}{5s} = \boxed{-2\frac{m}{s^2}}$$

34) What is the average acceleration of the particle between time t=2s and t=5s?

$$\bar{a} = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{T_f - T_i} = \frac{-10\frac{m}{s} - 5\frac{m}{s}}{5s - 2s} = \frac{-15\frac{m}{s}}{3s} = \boxed{-5\frac{m}{s^2}}$$

35) What is the displacement of the particle between time t=0s and t=3s?



Area of Triangle + Area of Trapezium

$\frac{1}{2}(2)(5) + \frac{1}{2}(5+15)(1) = 5 + 10 = \boxed{15\,m}$

36) When (after the start) is he object stationary again?

$\boxed{\text{at } 4.6\,s}$

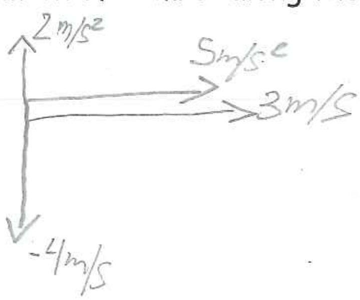
Answers

1) -4m 14m
2) +1m 13m
3) -1m 17m
4) -3m 15m
5) +14m 22m
6) -1m/s 8m/s
7) -2m/s 3.66m/s
8) +0.5m/s 2.5m/s
9) -3m/s 5m/s
10) $-2m/s^2$
11) $+4.5m/s^2$
12) $+2m/s^2$
13) +2m; +3m/s; $0M/s^2$
14) +7m; +16m/s; $+8m/s^2$
15) +33m; +16m/s; $+4m/s^2$
16) She is travelling to the right while speeding up.
17) She is travelling to the left while speeding up.
18) She is travelling to the right while slowing down.
19) Acceleration
20) Velocity
21) Jerk
22) Displacement
23) Change in velocity
24) +30m
25) -30m
26) +20m/s
27) -6m/s
28) Moving in a positive direction.
29) Standing Still.
30) At t=4s.
31) The object first starts travelling in a negative direction at 4.6s.
32) -12.5m/s
33) $-2m/s^2$
34) $-5m/s^2$
35) +15m
36) The object is stationary at 4.6s.

2048 Assignments Chapter 4

2D Motion Using Components

A particle starts from the origin. It has an initial velocity of +3 m/s and a constant acceleration of +5 m/s^2 along the X axis. It has an initial velocity of -4m/s and a constant acceleration of +2m/s^2 along the y axis.



1) What is its X component of velocity after 6s?

$V_i = 3\frac{m}{s}$ | $V_f = V_i + a\Delta T$

$a = 5\frac{m}{s^2}$ | $V_f = 3 + 5(6)$

$\Delta t = 6s$ | $V_f = 3 + 30$

$V_f = ?$ | $\boxed{V_f = 33\frac{m}{s}}$

2) What is its Y component of velocity after 6s?

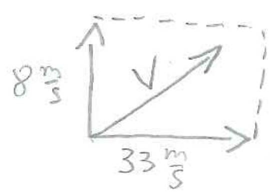
$V_i = -4\frac{m}{s}$ | $V_f = V_i + a\Delta T$

$a = 2\frac{m}{s^2}$ | $V_f = -4 + 2(6)$

$\Delta t = 6s$ | $V_f = -4 + 12$

$\boxed{V_f = 8\frac{m}{s}}$ //

3) What is the magnitude of its velocity after 6s?



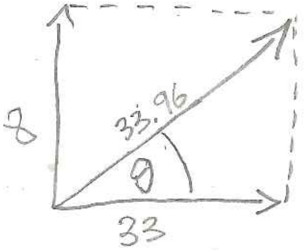
$V = \sqrt{33^2 + 8^2}$

$V = \sqrt{1153}$

$\boxed{V = 33.96}$

4) What is the direction of its velocity (with respect to the positive x-axis) after 6s?

angle



$\tan\theta = \frac{8}{33}$

$\theta = \tan^{-1}\left(\frac{8}{33}\right)$

$\boxed{\theta = 13.63°}$

$\cos\theta = \frac{33}{33.96}$

$\theta = \cos^{-1}\frac{33}{33.96}$

$\theta = 13.66°$ ✓

5) What is the X component of its displacement after 6s?

$\Delta X = ?$

$V_i = 3\frac{m}{s}$

$a = 5\frac{m}{s^2}$

$\Delta t = 6s$

$V_f = 33\frac{m}{s}$

$\Delta X = \frac{1}{2}(V_i + V_f)\Delta T$

$\Delta X = \frac{1}{2}(3+33)6$

$\Delta X = 3(36)$

$\boxed{\Delta X = 108\,m}$

6) What is the Y component of its displacement after 6s?

$V_i = -4\frac{m}{s}$

$V_f = 8\frac{m}{s}$

$a = 2\frac{m}{s^2}$

$\Delta t = 6s$

$\Delta X = ?$

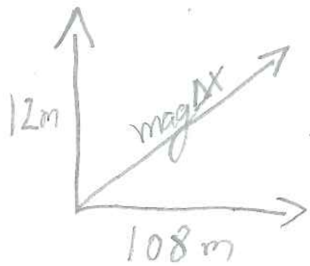
$\Delta X = \frac{1}{2}(V_i + V_f)\Delta t$

$\Delta X = \frac{1}{2}(-4+8)6$

$\Delta X = 3(4)$

$\boxed{\Delta X = 12\,m}$

7) What is the magnitude of its displacement after 6s?

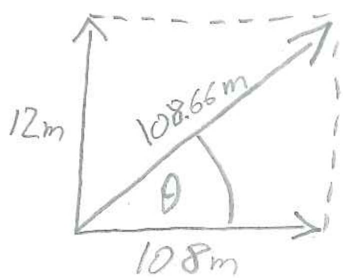


$$Mag = \sqrt{12^2 + 108^2}$$

$$mag = \sqrt{11808}$$

$$\boxed{mag = 108.66\,m}$$

8) What is the direction of its displacement (with respect to the positive x-axis) after 6s?

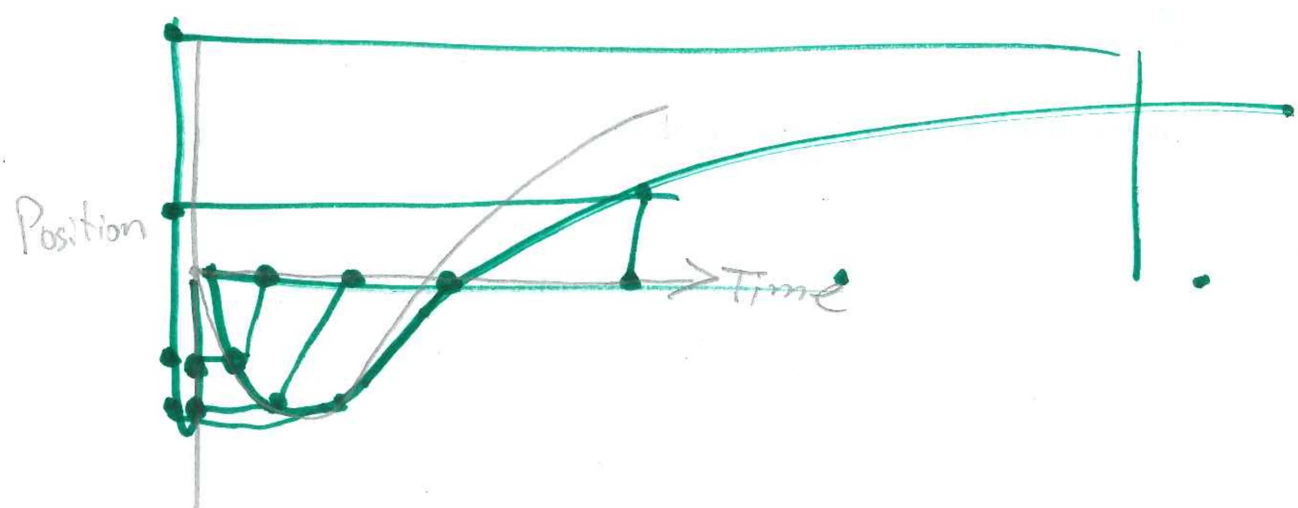


$$\sin\theta = \frac{12}{108.66}$$

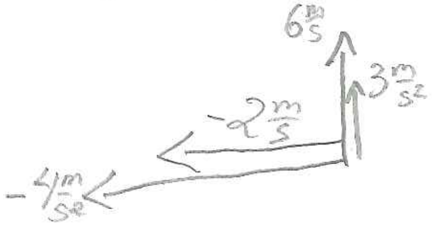
$$\theta = \sin^{-1}\left(\frac{12}{108.66}\right)$$

$$\boxed{\theta = 6.34°}$$

9) Draw a sketch of the particle's path in time.



A particle starts from the origin. It has an initial velocity of -2 m/s and a constant acceleration of -4 m/s^2 along the X axis. It has an initial velocity of +6m/s and a constant acceleration of +3m/s^2 along the y axis.



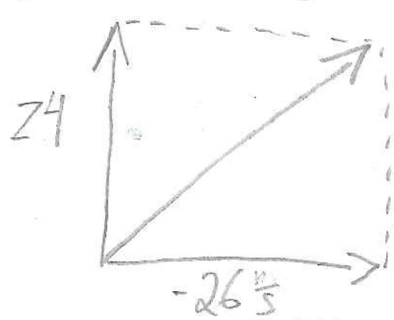
10) What is its X component of velocity after 6s?

$V_f = ?$	$V_f = V_i + a\Delta T$
$V_i = -2\frac{m}{s}$	$V_f = -2 + (-4)6$
$a = -4\frac{m}{s^2}$	$V_f = -2 - 24$
$\Delta T = 6s$	$\boxed{V_f = -26\frac{m}{s}}$

11) What is its Y component of velocity after 6s?

$V_f = ?$	$V_f = V_i + a\Delta T$
$V_i = 6\frac{m}{s}$	$V_f = 6 + 3(6)$
$a = 3\frac{m}{s^2}$	$V_f = 6 + 18$
$\Delta T = 6s$	$\boxed{V_f = 24\frac{m}{s}}$

12) What is the magnitude of its velocity after 6s?

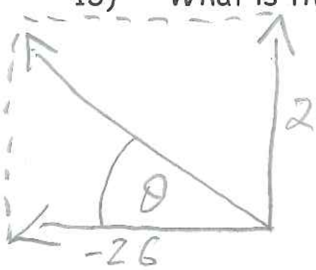


$$mag = \sqrt{24^2 + (-26)^2}$$

$$mag = \sqrt{1252}$$

$$\boxed{mag = 33.88\frac{m}{s}}$$

13) What is the direction of its velocity after 6s?



$\tan\theta = \frac{+24}{+26}$

$\theta = \tan^{-1}\left(\frac{+24}{+26}\right)$

$\boxed{\theta = +42.71°}$ above X-axis

14) What is the X component of its displacement after 6s?

$V_f = -26\ \frac{m}{s}$

$V_i = -2\ \frac{m}{s}$

$\Delta T = 6s$

$\Delta X = ?$

$\Delta X = \frac{1}{2}(V_i + V_f)\Delta T$

$\Delta X = \frac{1}{2}(-2-26)6$

$\Delta X = 3(-28)$

$\boxed{\Delta X = -84\ m}$

15) What is the Y component of its displacement after 6s?

$V_i = 6\ \frac{m}{s}$

$V_f = 24\ \frac{m}{s}$

$\Delta T = 6s$

$\Delta X = ?$

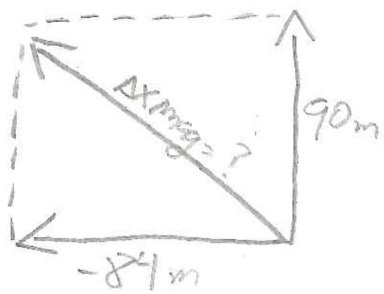
$\Delta X = \frac{1}{2}(V_i + V_f)\Delta T$

$\Delta X = \frac{1}{2}(6+24)6$

$\Delta X = 3(30)$

$\boxed{\Delta X = 90m}$

16) What is the magnitude of its displacement after 6s?

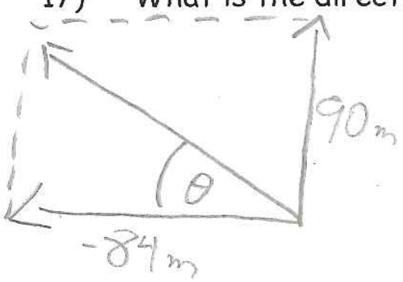


$\Delta x_{mag} = \sqrt{(-84)^2 + 90^2}$

$\Delta x_{mag} = \sqrt{15156}$

$\boxed{\Delta x_{mag} = 123.11\,m}$

17) What is the direction of its displacement after 6s?



$\tan\theta = \frac{90}{84}$

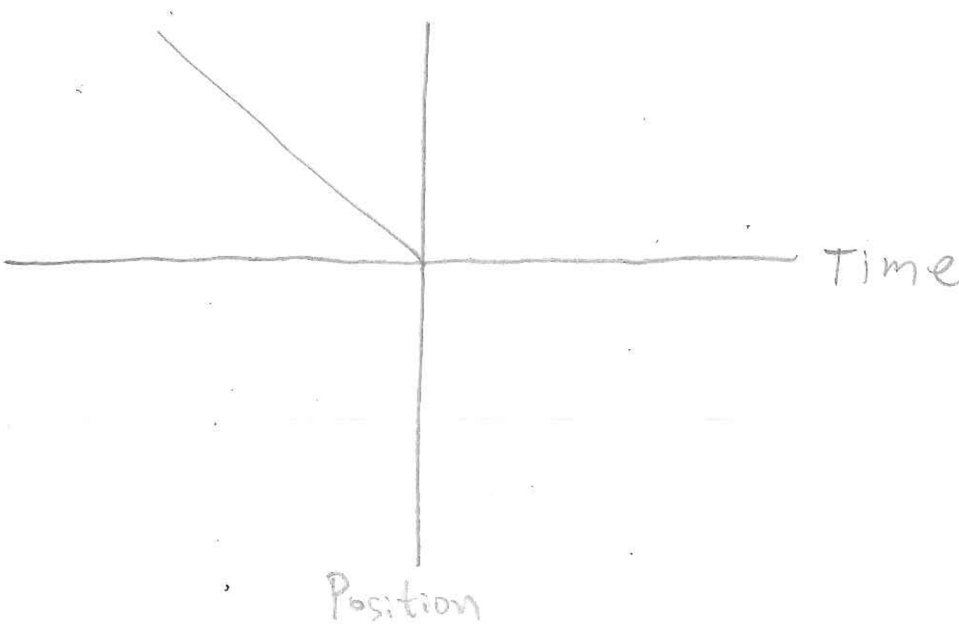
$\theta = \tan^{-1}\left(\frac{90}{84}\right)$

$\theta = 46.97°$

$\theta = 180 - 46.97°$

$\boxed{\theta = 133.03°}$

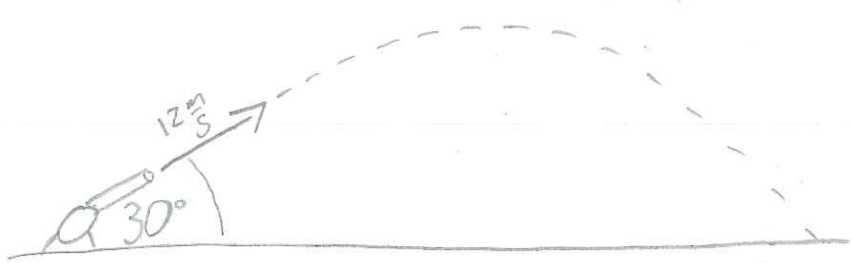
18) Draw o sketch of the particle's path in time.



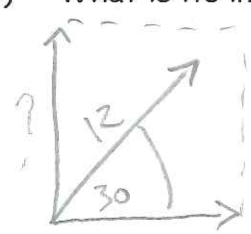
Projectile Motion Using Components

A cannonball is fired across a level field with a muzzle speed of 12m/s at 30 degrees elevation above the horizontal.

19) Sketch a diagram of this.



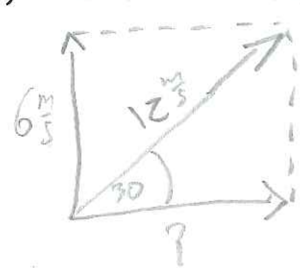
20) What is its initial vertical component of velocity?



$12 \sin 30 = \boxed{+6 \frac{m}{s}}$

So is initial velocity 12 m/s muzzle speed or 12 Sin 30?

21) What is its initial horizontal component of velocity?



$12 \cos 30° = \boxed{10.39 \frac{m}{s}}$

22) What is its vertical component of acceleration?

Vertical acceleration is the constant force of gravity

$$\boxed{a = -10\,\frac{m}{s^2}}$$

23) What is its horizontal component of acceleration?

No forces acting upon a particle once launched & before it stops

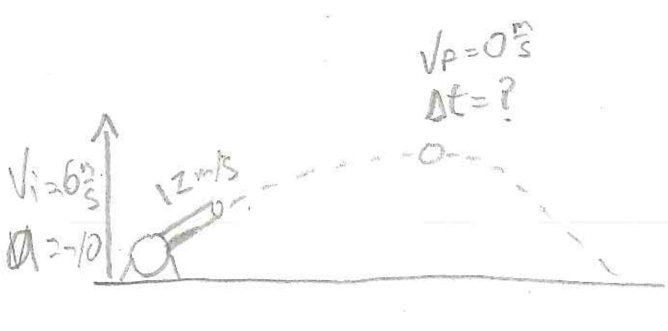
$$\boxed{a = 0\,\frac{m}{s^2}}$$

24) How long does it take the ball to reach its maximum height?

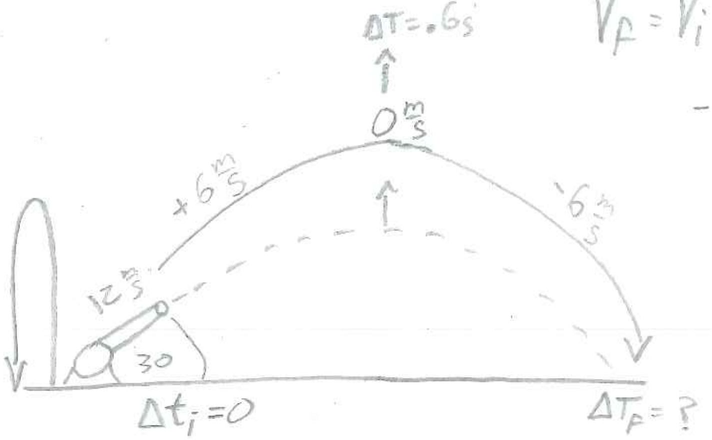
$$V_f = V_i + a\Delta T$$

$$\Delta T = \frac{V_f - V_i}{a} = \frac{0\,\frac{m}{s} - 6\,\frac{m}{s}}{-10\,\frac{m}{s^2}} = \frac{-6\,\frac{m}{s}}{-10\,\frac{m}{s^2}}$$

$$\boxed{\Delta t = 0.6\,s}$$



25) What is the balls hang-time?



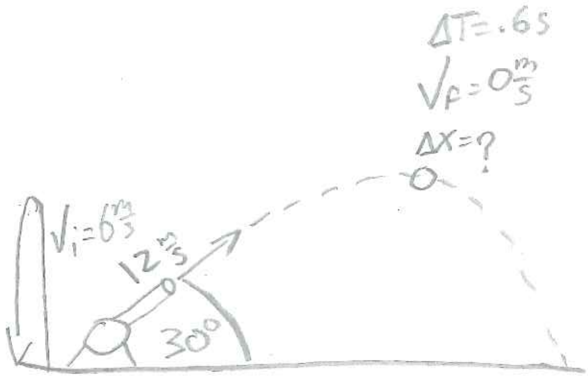
$V_f = V_i + a\Delta T$

$-6\frac{m}{s} = 6\frac{m}{s} + (-10\frac{m}{s^2})\Delta T$

$\Delta T = \frac{-6-6}{-10} = \frac{-12}{10}$

$\boxed{\Delta T = 1.2s}$

26) What is the ball's maximum height?



$\Delta X = \frac{1}{2}(V_i + V_f)\Delta T$

$\Delta X = \frac{1}{2}(6+0)0.6$

$\Delta X = 0.3(6)$

$\boxed{\Delta X = 1.8m}$

27) What is the ball's range?

$V_i = 10.39\frac{m}{s}$

$a = 0\frac{m}{s^2}$

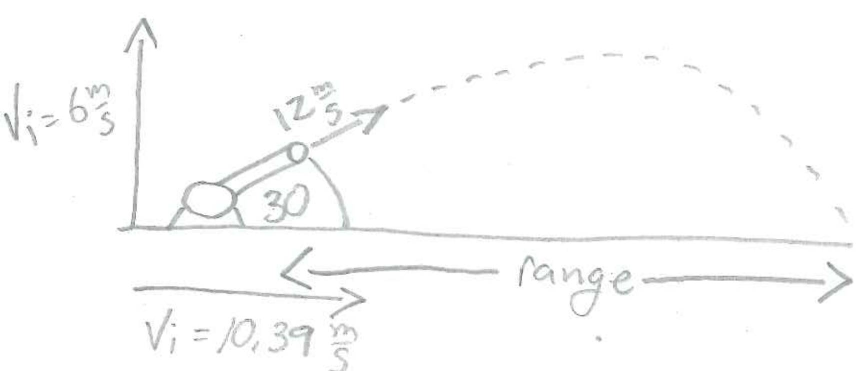
$\Delta T = 1.2s$

$\Delta X_r = V_i\Delta T + a\Delta t^2$

$\Delta X_r = (10.39)(1.2) + (0)(1.2)^2$

$\Delta X_r = 12.468 + 0$

$\boxed{\Delta X_r = 12.47m}$



28) What is the ball's vertical component of velocity at its maximum height?

at max height, Velocity of ball will be $\boxed{0 \frac{m}{s}}$

29) What is the balls horizontal component of velocity at its maximum height?

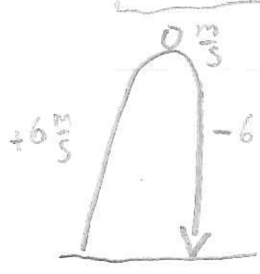
no forces act on ball once projected. Ball fired at $\boxed{10.39 \frac{m}{s}}$ will remain constant Until another force acts on it

30) What is the ball's vertical component of velocity the instant before it hits the ground?

$V_f = V_i + a\Delta T$

$V_f = 6 + (-10)(1.2)$

$\boxed{V_f = -6 \frac{m}{s}}$

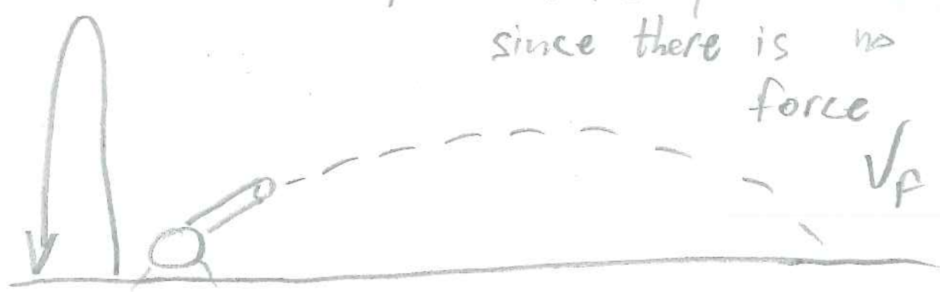


Conceptually, Velocity of ball at the same height is its negative reciprocal

31) What is the ball's horizontal component of velocity the instant before it hits the ground?

Horiz Velocity is constant since there is no acceleration force

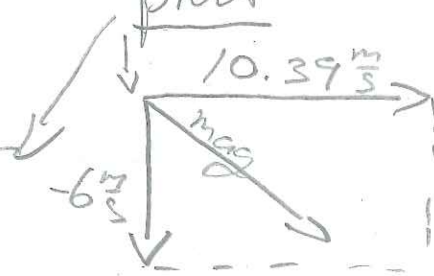
$V_f = 10.39\frac{m}{s}$



32) What is the magnitude of the ball's velocity the instant before it hits the ground?

Parabolla so final mag is = initial mag

proof



mag $\sqrt{1039^2 + (-6)^2} = \boxed{12\frac{m}{s}}$

33) What is the angle of elevation of the ball's trajectory the instant before it hits the ground?

$\theta = \alpha$

$\theta = 30°$ ∴ $\boxed{\alpha = 30°}$

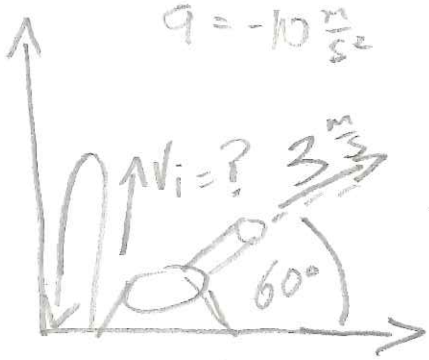
A cannonball is fired across a level field with a muzzle speed of 3m/s at 60 degrees elevation above the horizontal.

34) Sketch a diagram of this.

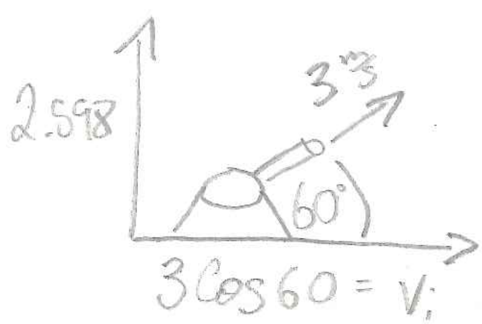
35) What is its initial vertical component of velocity?

$V_i = ?$
$g = -10 \frac{m}{s^2}$

$V_i = 3 \sin 60 = \boxed{2.598 \frac{m}{s}}$



36) What is its initial horizontal component of velocity?

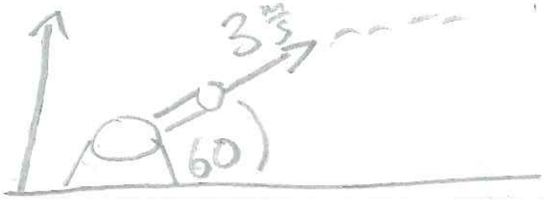


$V_i = 3 \cos 60°$

$\boxed{V_i = 1.5 \frac{m}{s}}$

37) What is its vertical component of acceleration?

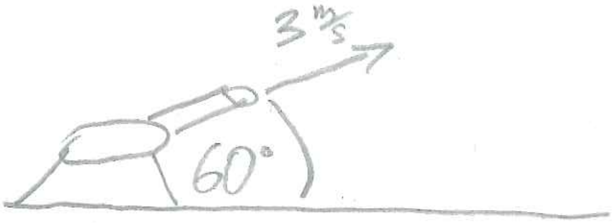
acceleration vertically is a constan $-10 \frac{m}{s^2}$ due to gravity.



38) What is its horizontal component of acceleration?

$\overleftrightarrow{\text{acceleration}} = 0 \frac{m}{s^2}$

no force acts on the particle once it's launched



39) How long does it take the ball to reach its maximum height?

$V_i = 2.598 \frac{m}{s}$

$V_f = 0 \frac{m}{s}$

$a = -10 \frac{m}{s^2}$

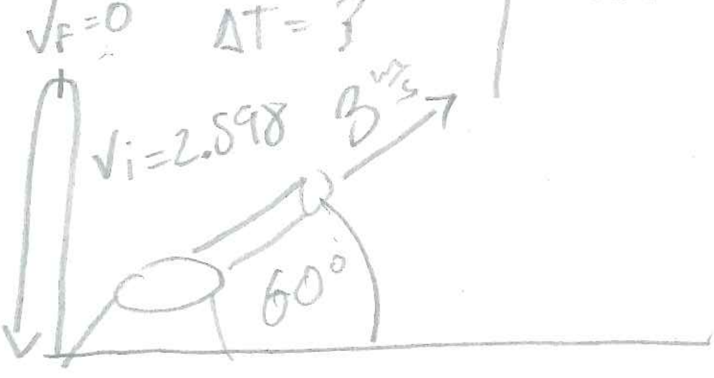
$\Delta T = ?$

$V_f = V_i + a\Delta T$

$0 = 2.598 - 10\Delta T$

$\Delta T = \frac{-2.598}{-10}$

$\boxed{\Delta T = .26\,s}$



40) What is the balls hang-time?

ball hang time = 2 x ΔT of ball at maximum height

$2\Delta T = 2(.26)$

$\boxed{= .52s}$

41) What is the ball's maximum height?

42) What is the ball's range?

43) What is the ball's vertical component of velocity at its maximum height?

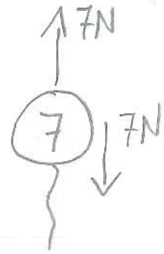
44) What is the balls horizontal component of velocity at its maximum height?

45) What is the ball's vertical component of velocity the instant before it hits the ground?

2048 Newton's Laws Homework

One Dimensional Net Force, Equilibrium and Acceleration

A balloon weighs 7N. It has an upward, (buoyant) force of 7N.



1) What vertical net force acts on it?

$\sum F_{net} = (+7N) + (-7N) = \boxed{0N}$

2) Is the balloon in equilibrium vertically?

$\sum F = 0$, yes the balloon is in equilibrium

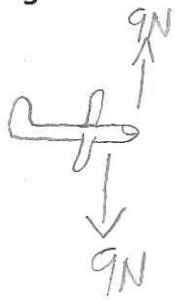
3) What is the balloon's vertical acceleration?

$\boxed{\text{No}}$ vertical acceleration because there is no net vertical force

4) Does the balloon have constant vertical velocity?

$\boxed{\text{Yes}}$ Since there is no acceleration, the balloon <u>is</u> maintaining a constant velocity of $0 \frac{m}{s}$

An airplane weighs 9N. It has a lift force of 9N.



5) What vertical net force acts on it?

$\sum F_{net} = 9N + (-9N) = \boxed{0N}$

6) Is the airplane in equilibrium vertically?

$\boxed{\text{Yes}}$ Since there are no net external forces acting on it

7) What is the airplane's vertical acceleration?

$\boxed{V_{acceleration} = 0 \frac{m}{s^2}}$ Since there are no external forces acting on it

8) Does the airplane have constant vertical velocity?

$\boxed{\text{Yes}}$ Vertical velocity is maintained at a constant $\boxed{0 \frac{m}{s}}$