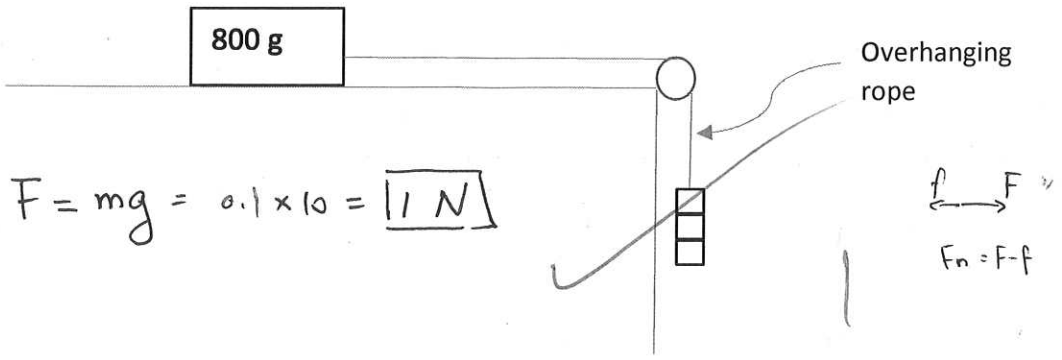
28/35.

First Year December Block Week Test Name: Maggie

1/ A student performs an experiment to determine the properties of friction. The following setup includes an 800 gram mass on a desk attached to a rope running over a pulley. Masses are gradually added to the overhanging rope until the system starts to move. A maximum of 200 grams is added to the overhanging rope before the system starts to move.

(a) What is the force of friction acting on the 800 gram mass when only 100 grams is added to the overhanging rope? 1 mark



$F = mg = 0.1 \times 10 = \boxed{1\ N}$

The 800 g mass moves with an acceleration of 0.5 ms^{-2} when 200 grams is placed on the overhanging rope.

(b) What is the magnitude of force of friction acting on the 800 gram mass? 2 marks

$F_{net} = ma = (0.8+0.2)(0.5) = 0.5N.$

$f = F - F_{net} = 0.2 \times 10 - 0.5 = \boxed{1.5N}$ 2

(c) What is the force of friction if 300 grams is added to the overhanging rope? 2 marks

$\boxed{1.5N}$ because $f = \mu N$, where N is the force of the mass onto the surface, when 300g is added, it doesn't change the force of the mass onto the table. 2

The student adds an additional 400 grams on top of the 800 gram mass.

(d)How much overhanging mass is needed to move the system? 2 marks

1.2 M

$\mu = \frac{f}{N} = \frac{1.5}{0.8 \times 10} = 0.1875$

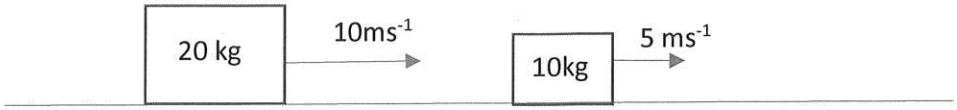
$F = (0.8+0.4) \times 10 \times 0.1875$

$= 2.25$

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

$= \frac{2.25}{10} = \boxed{225\ g}$ 1

2/ Two masses are moving across a frictionless surface as shown below



The 2 objects collide and the 10 kg mass moves off with a velocity of 7 ms^{-1} after the collision.

(a) What is the change in momentum for the 10 kg mass? 2 marks

$\Delta P_1 = m_1 \Delta v_1 = 10 \times (7-5) =$ **20 kg ms^{-1}** ✓ 2

(b) What is the change in momentum for the 20 kg mass? 1 mark

Because of the conservation of momentum.

$\Delta P_2 + \Delta P_1 = 0$. $\Delta P_2 =$ **-20 kg ms^{-1}** ✓ 1

(c) How much kinetic energy is lost in the collision? 2 marks

$\Delta v_2 = \frac{-20}{20} = -1\ ms^{-1}$ $E_k = \frac{1}{2}(20)(10^2) + \frac{1}{2}(10)(5^2) = 1125\ J$

$v_2 = 10 - 1 = 9\ ms^{-1}$ $E_k' = \frac{1}{2}(20)(9^2) + \frac{1}{2}(10)(7^2) = 1055\ J$

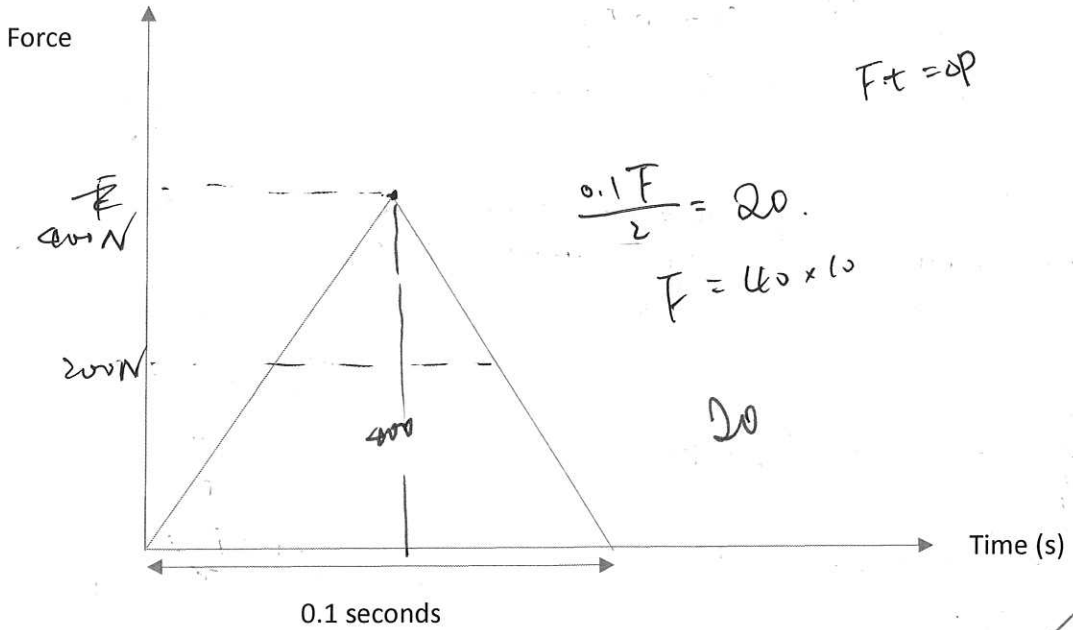
$\Delta E_k = 1125 - 1055 =$ **70 J** ✓ 2

(d) Which mass receives the greatest force? 1 mark

According to Newton's third law.

The two masses receive the same magnitude of force.

The graph below shows the force acting on the 10 kg mass while in contact with the 20 kg mass.



$Ft = \Delta P$

$\frac{0.1F}{2} = 20$.

$F = 40 \times 10$

20

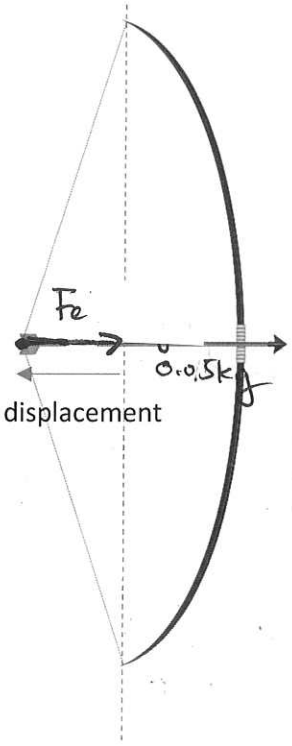
✓ 2

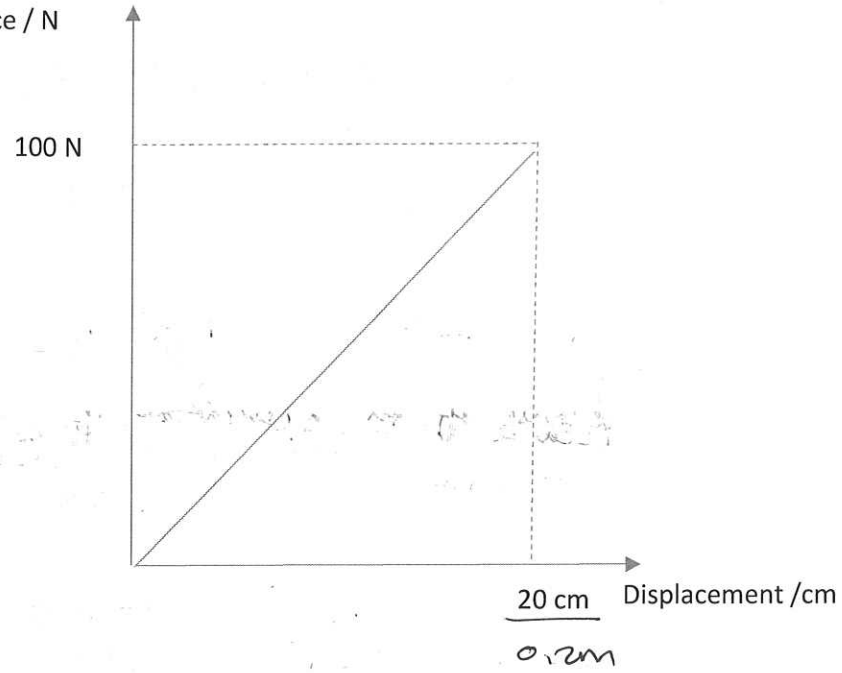
(e) What is the magnitude of the maximum force shown on the graph? 2 marks

$F = \frac{\Delta P}{t} = \frac{20\ kg ms^{-1}}{0.1\ s} = 200N.$, which is the average force,

So the maximum is **400N**.

3/ A student wishes to test the properties of a bow (bow and arrow) for their physics IA. The graph below shows the force required to displace the string of the bow. The mass of the arrow is 50 grams.





(a) Label the direction of the elastic force acting on the arrow in the position shown. 1 mark ✓1

(b) What is the average acceleration of the mass while in contact with the string ? 2 marks

$a = \frac{F}{m} = \frac{100N}{0.05} = 2000\ ms^{-2}$ ✓1

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

(c) What is the maximum speed of the arrow? 2 marks

$E_k = E_p$

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

$0.05v^2 = 100 \times 0.2$

$v = 20\ ms^{-1}$ ✓2

(d) What is the average power of the bow? 2 marks

$P = \frac{W}{t} = F \cdot v = 100N \times 20 = 2000W$

$v = at + u$. ✓1

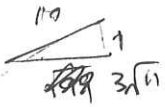
$20 = 2000t$.

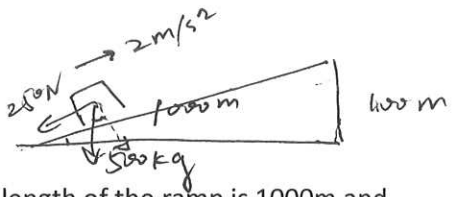
$t = \frac{1}{100}s$

$P = \frac{W}{t} = \frac{\frac{1}{2}Fs}{\frac{1}{100}} = 1000\ W$

(e) The arrow hits a target at maximum speed and comes to rest after embedding 0.05 m into the target. How much work is done in bringing the arrow to rest? 2 marks

$W = \Delta E_k = \frac{1}{2}(0.05)(20^2) = 10\ J$ ✓2





4/ A 500 kg car is ascending a ramp with an acceleration of 2 ms^{-2}. the length of the ramp is 1000m and the height is 100 meters. The opposing frictional force is 250N

(a) What is the net force on the car 1 mark

$F = ma = 500 \times 2 = 1000\,N$

$s = 1000m$
$a = 2m/s$
$u = 0$

(b) What force does the car exert on the road 2 marks

$F = 500 \times \cos\theta = 500 \times \frac{\sqrt{99}}{10} = 497\,N.$

(c) What is the power of the car assuming the car starts from rest 2 marks

$P = \frac{F \cdot s}{t}$

$= \frac{(1000 + 250 + 50) \times 1000}{\sqrt{1000}}$

$= \frac{1300 \times 1000}{\sqrt{1000}}$

$= 4.1 \times 10^4\,W$

$= 500 \times 100 \times 100$

$= 5 \times 10^5\,J.$

$P = \frac{W}{t} = \frac{\Delta Ek - \Delta Ep}{t}$

$= \frac{15 \times 10^5}{32}$

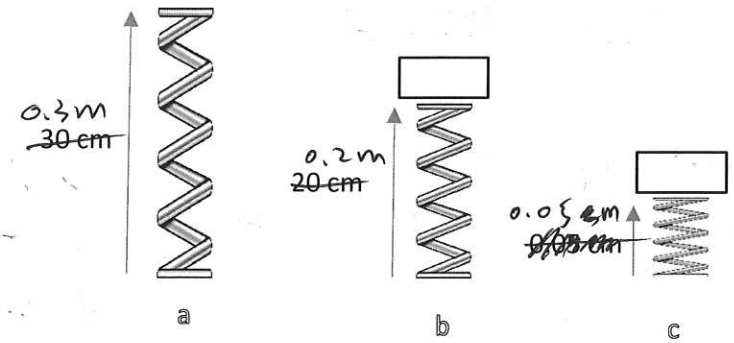
$= 4.7 \times 10^4\,W$

5/ A spring in its natural length is shown below in diagram a. A 0.50 kg mass is placed on the spring and lowered to its equilibrium position as shown in diagram b.

(a) What is the spring constant of the spring? 2 marks

$k = \frac{F}{x} = \frac{0.5 \times 10}{0.1} = 50\,N\,m^{-1}$

The mass is then forced down further as shown in diagram c and released.



(b) What will be its maximum speed in the absence of air resistance? 2 marks

$\Delta Ek = \Delta Ep$

$\frac{1}{2}mv^2 = \frac{1}{2}50(0.15)^2$

$v^2 = \frac{50(0.15)^2}{0.5}$

$= 2.25$

$v = 1.5\,ms^{-1}$

$a = -10$
$v = 1.5$
$u = 0$

(c) How high will it go in the absence of air resistance relative to its position in c? 2 marks

$v^2 - u^2 = 2as$

$a^2 - 1.5^2 = 2(-10) \cdot s$

$s = \frac{-1.5^2}{-20} = 0.1125m.$

So it will go up to 0.1m relative to its position in c.