First Name:_____    Last Name:_____
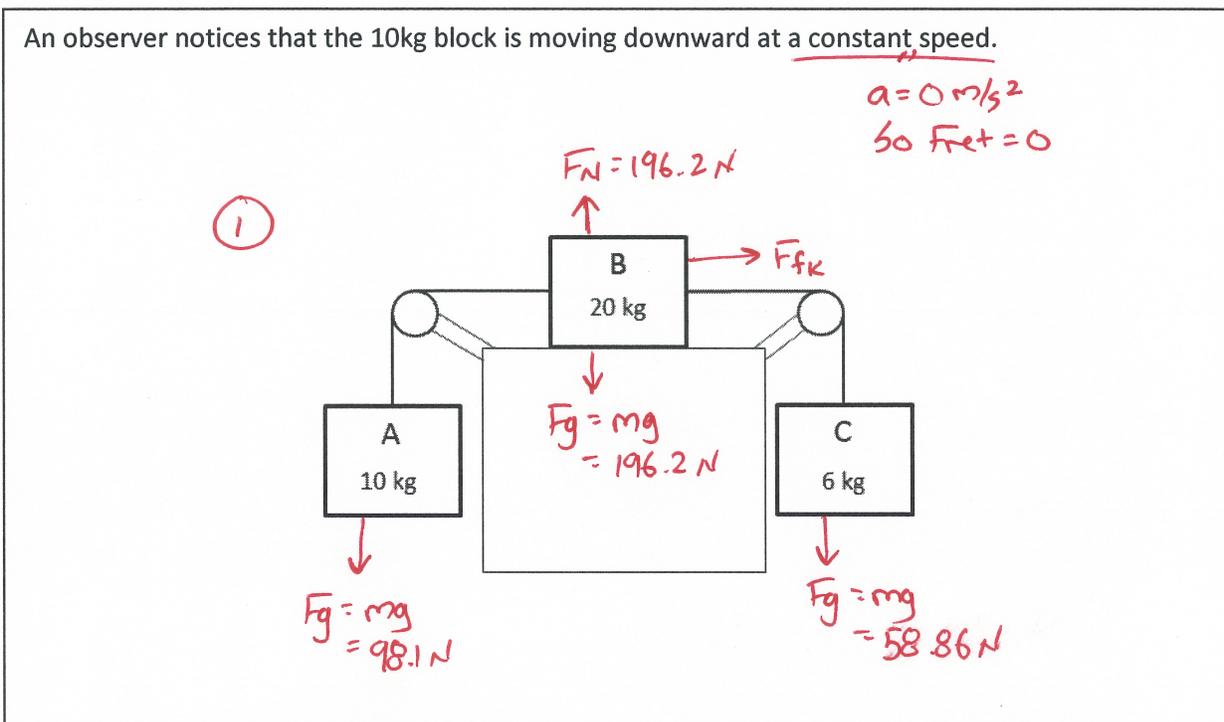
# L10 – Worksheet – Pulleys and Blocks                    /12 marks

**Part 1:** Systems with Pulleys

*Use the following information to answer Q1:*

An observer notices that the 10kg block is moving downward at a constant speed.

$a = 0 \, m/s^2$
so $F_{net} = 0$

① 

B
20 kg

$F_N = 196.2 N$

→ $F_{fk}$

$F_g = mg$
$= 196.2 \, N$

A
10 kg

$F_g = mg$
$= 98.1 \, N$

C
6 kg

$F_g = mg$
$= 58.86 \, N$

**Q1:** *(Long Answer)* What is the coefficient of kinetic friction between the 20kg block and the table? *(3 marks)*

/3

$$F_{net} = F_{g_{10}} + F_{f_{20}} + F_{g_6}$$
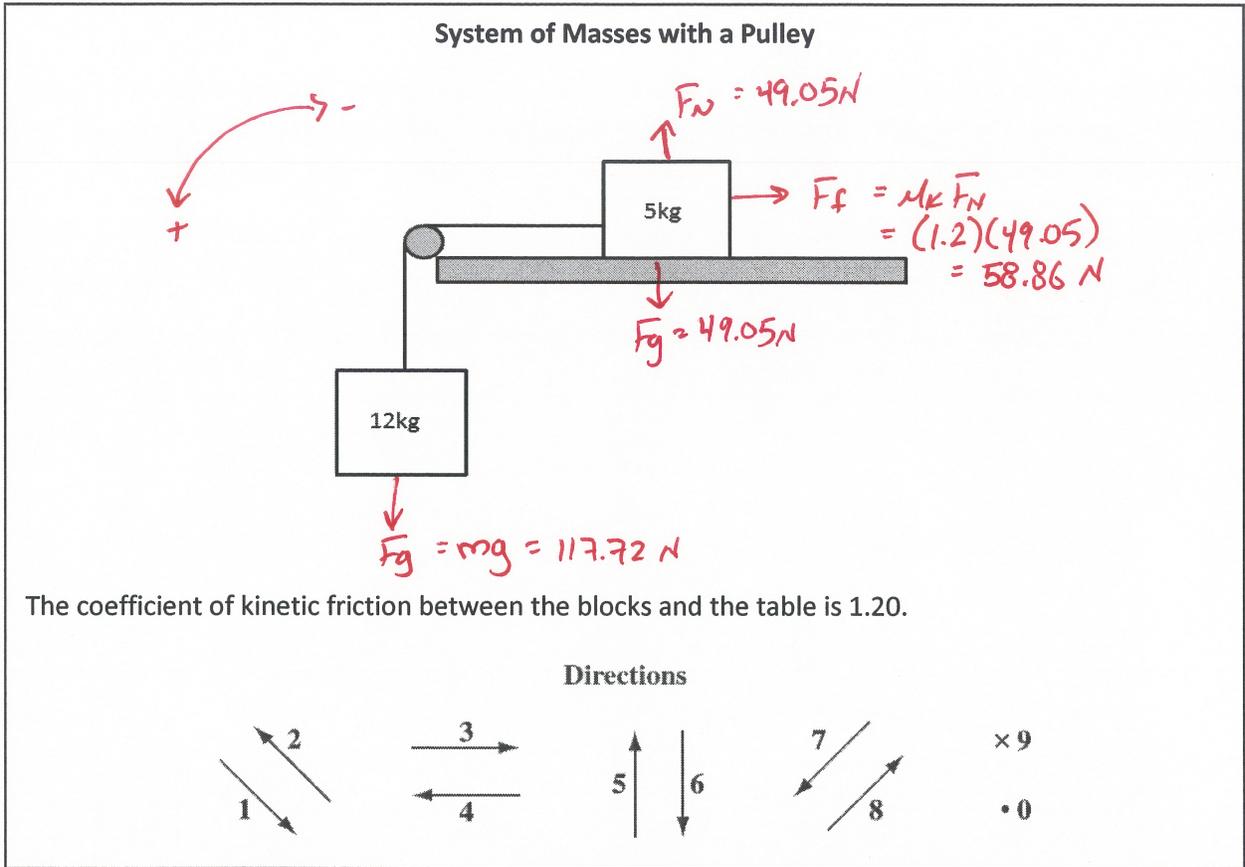
$$0 = 98.1 + F_{fk} + (-58.86)$$

① $\boxed{F_{fk} = -39.24 \, N \text{ [forward]}}$

$$F_f = \mu_k F_N$$
$$39.24 \, N = \mu_k (196.2 \, N)$$

① $\boxed{\mu_k = 0.20}$

*Use the following information to answer Q2 – Q4:*

**System of Masses with a Pulley**

$F_N = 49.05 N$

5kg

$F_f = M_k F_N$
$= (1.2)(49.05)$
$= 58.86 N$

$F_g = 49.05 N$

12kg

$F_g = mg = 117.72 N$

The coefficient of kinetic friction between the blocks and the table is 1.20.

**Directions**

2

3

1

4

5 | 6

7

8

× 9

• 0

**Q2:** The directions of force and force components can be described using the numbers given above.

| Direction: | 5 | 3 | 6 | 5 |
|---|---|---|---|---|
| Force: | Normal Force on 5kg Box | Friction on 5kg | Direction of acceleration of the 12kg block | Direction of Force of Tension on 12kg block |

*(Record your **four digit** answer in the Numerical Response boxes below)*

| 5 | 3 | 6 | 5 | |
|---|---|---|---|---|

**Q3:** What is the acceleration of the system?

a. 3.46 m/s² *(circled)*
b. 4.91 m/s²
c. 6.92 m/s²
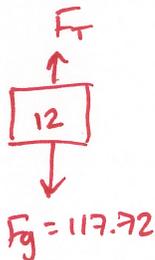d. 11.8 m/s²

$$F_{net} = Fg_{12} + Ff_5$$
$$= (+117.72) + (-58.86)$$
$$= 58.86 N$$

$$\vec{a} = \frac{\vec{F_{net}}}{m} = \frac{58.86 N}{17 kg} = 3.46 \, m/s^2$$

**Q4:** The tension in the rope is $a.bc \times 10^d$ N, where $a, b, c,$ and $d$ are ___, ___, ___, and ___.

*(Record your **four digit** answer in the Numerical Response boxes below)*

| 7 | 6 | 2 | 1 |
|---|---|---|---|

**Option #1**

$F_T$ ↑

| 12 |

↓ $Fg = 117.72$

$$F_{net} = ma$$
$$= (12)(3.46)$$
$$= 41.55 N$$

$$F_{net} = Fg + F_T$$
$$41.55 = 117.72 + F_T$$
$$F_T = 76.17 N$$

**Option #2**

$F_T$ ←

| 5 | → $Ff = 58.86 N$
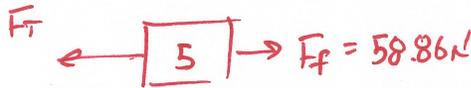
$$F_{net} = ma$$
$$= (5)(3.46)$$
$$= 17.31 N$$

$$F_{net} = F_T + Ff$$
$$17.31 = F_T + (-58.86)$$
$$F_T = 76.17 N$$

**Scientific Notation**

$$F_T = 76.17 N$$
$$= 7.617 \times 10^1 N$$
$$\approx 7.62 \times 10^1$$
$$a.bc \times 10^d$$

| 7 | 6 | 2 | 1 |
|---|---|---|---|

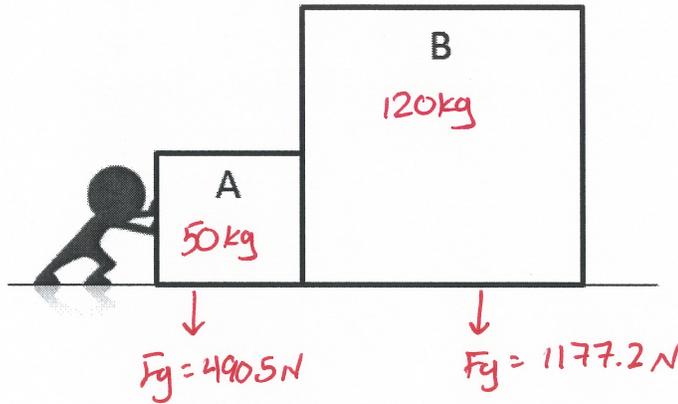**Part 2:** Blocks Pushing Blocks

*Use the following information to answer Q5 and Q6:*

A person applies an unknown force to Block A, accelerating the entire system at a rate of 0.65 m/s². Block A has a mass of 50kg, and Block B has a mass of 120kg, and the coefficient of friction between the blocks and the floor is 0.38.

B

120kg

A

50kg

$F_g = 490.5N$     $F_g = 1177.2N$

**Q5:** In order to accelerate the system at a rate of 0.65 m/s², the person must have applied a force of

   a.  110.5 N

   b.  296.9 N

   c.  523.2 N

  (d.) 744.2 N

System 170kg     Fapp

$F_f = \mu_k F_N$
$= (0.38)(1667.7 N)$
$= 633.726 N$

$F_{net} = ma$
$= (170kg)(0.65 \text{ m/s}^2)$
$= 110.5N$

$F_{net} = F_{app} + F_f$
$110.5 = F_{app} + (-633.726)$
$F_{app} = 744.226 N$

**Q6:** The force that Block B applies to Block A is

   a.  78.0 N

   b.  369.3 N

  (c.) 525.3 N

   d.  711.7 N

B 120kg     $F_{A on B}$

$F_f = \mu_k F_N$
$= (0.38)(1177.2)$
$= 447.336 N$

$F_{net} = ma$
$= (120kg)(0.65 \text{ m/s}^2)$
$= 78N$

$F_{net} = F_{A on B} + F_f$
$78N = F_{A on B} + (-447.336N)$
$F_{A on B} = 525.336 N$

*Use the following information to answer Q7:*

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### Contrasting Systems of Masses

| *Systems with Pulleys* | *Blocks pushing Blocks* |
|---|---|
| 5kg / 12kg (pulley system) | B / A (blocks) |

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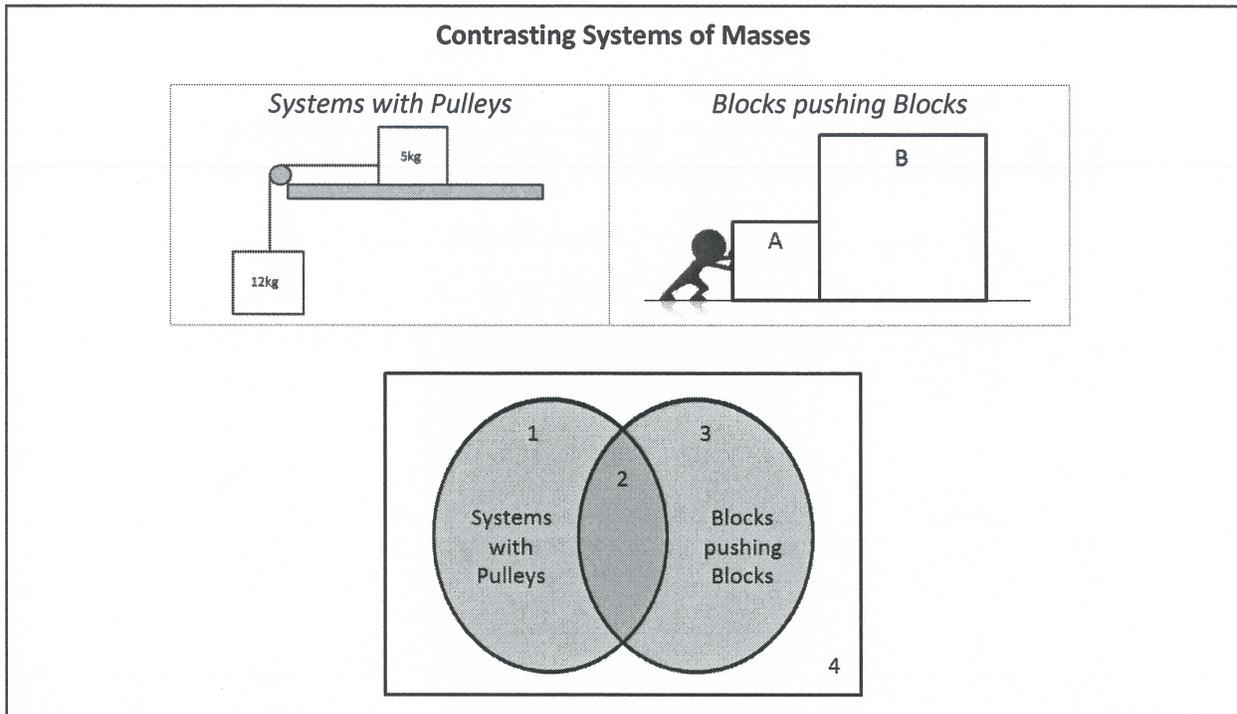
**Q7:** Match the numbers of the regions in the Venn diagram above with the descriptions given below.

| **Region:** | **2** | **3** | **3** | **1** |
|---|---|---|---|---|
| **Description:** | The entire system and individual items accelerate at the same rate. | The entire system and individual items accelerate in the same direction. | Friction acts on all items in the system. | Internal forces between items can be described as "pulls" rather than "pushes". |

*(Record your **four digit** answer in the Numerical Response boxes below)*

| 2 | 3 | 3 | 1 |
|---|---|---|---|

*Use the following information to answer Q8:*

A person pushes a series of boxes with a force of 200 N [Right]. Assume that the surface is frictionless.
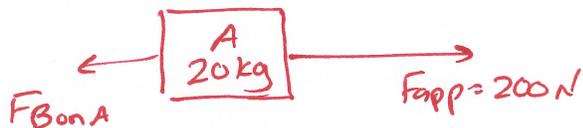
```
                    B
                  45 kg
        A                    C
       20 kg              25 kg
```
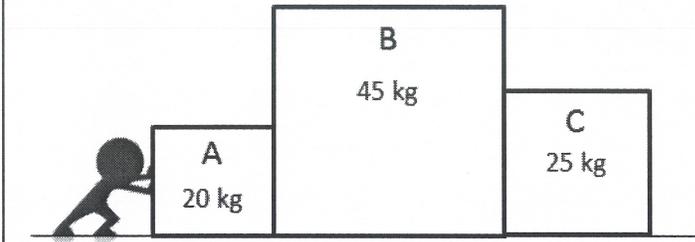
**Q8:** *(Long Answer)* What is the force (magnitude and direction) that Block A applies to Block B? *(3 marks)*

**System**

$$\vec{a} = \frac{\vec{F}_{net}}{m} = \frac{200 N}{90 kg} = \boxed{2.\overline{2} \, m/s^2 \, [R]} \quad ①$$

**Block A**

```
            A
   ←      20 kg      ──────→
F_Bon A              Fapp = 200 N
```

$$F_{net} = ma$$
$$= (20 kg)(2.\overline{2} \, m/s^2) = 44.\overline{4} \, N$$

$$F_{net} = F_{app} + F_{Bon A}$$
$$(+44.\overline{4} \, N) = (+200 \, N) + F_{Bon A}$$
$$F_{Bon A} = -155.\overline{5} \, N \, [R]$$
$$= 155.\overline{5} \, N \, [L]$$
$$\boxed{F_{Aon B} = 155.\overline{5} \, N \, [R]} \quad ②$$