

**Guided Responses to TAKS Self-Check Exam Practice IPC TEKS 4A, 4B, and 4D  
TX BDOL p TX28**

1. A car travels around a curve at a constant speed. Which of the following best describes the car's motion? (IPC 4A)

D) The car is accelerating.

**Solution** Velocity is the speed of an object combined with the direction of movement. Acceleration is the change in velocity divided by the time over which the change occurs. An object can accelerate by changing speed, changing direction, or by changing speed and direction. In this problem, the car is changing direction, so it is accelerating even though its speed is constant.

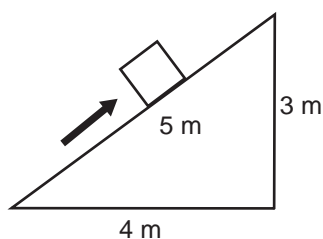
2. A cyclist travels 1500 m in 1 minute and 40 seconds. What is the cyclist's average speed? (IPC 4A)

G) 15.0 m/s

**Solution** The average speed of the cyclist can be calculated from the equation

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

where  $d$  is the total distance traveled and  $t$  is the total time elapsed. To calculate the average speed in units of m/s, first convert the time to units of seconds. One minute equals 60 seconds, so 1 minute and 40 seconds = 100 seconds. The average speed is then  $1500 \text{ m}/100 \text{ s} = 15 \text{ m/s}$ .



3. The efficiency of the inclined plane shown in the figure above is 80%. If the box weighs 400 N, how much work must be done to push the box to the top of the inclined plane? (IPC 4D)

A) 1500 J

**Solution** The efficiency of a machine is:

$$eff (\%) = \frac{W_{out}}{W_{in}} \times 100\%$$

Solve this equation for  $W_{in}$ :

$$W_{in} = W_{out} \times \frac{100\%}{eff (\%)}$$

Now find  $W_{out}$ . The output work done by the inclined plane is the work needed to lift the box 3 m high. If the box weighs 400 N, the force needed to lift the box is 400 N, so the output work is:

$$W_{out} = 400 \text{ N} \times 3 \text{ m} = 1200 \text{ J}$$

Now substitute this value and the efficiency into the equation you found for  $W_{in}$ :

$$W_{in} = 1200 \text{ J} \times (100\%/80\%) = 1500 \text{ J}$$

4. What is the ratio of the momentum of a 3000-kg car moving at 100.0 km/h to the momentum of a motorcycle with a mass of 150.0 kg traveling at 35.0 m/s? (IPC 4A)

F) 15.8

**Solution** To calculate this ratio, the momentum of the car and the motorcycle must have the same units. Then the units cancel when the momentum of the car is divided by the momentum of the motorcycle to calculate the ratio. Convert the speed of the car from km/h to m/s:

$$\begin{aligned} 100 \frac{\text{km}}{\text{h}} &= 100 \frac{\text{km}}{\text{h}} \times 1000 \frac{\text{m}}{\text{km}} \times \frac{\text{h}}{3600 \text{ s}} \\ &= 27.8 \frac{\text{m}}{\text{s}} \end{aligned}$$

Then the ratio of the car's momentum to the motorcycle's momentum is:

$$\begin{aligned} \frac{p_{\text{car}}}{p_{\text{cycle}}} &= \frac{m_{\text{car}} v_{\text{car}}}{m_{\text{cycle}} v_{\text{cycle}}} = \frac{3000\text{-kg} \times 27.8 \text{ m/s}}{150.0 \text{ kg} \times 35.0 \text{ m/s}} \\ &= 15.8 \end{aligned}$$

5. A mover uses a pulley system to lift a piano that weighs 1000 N. The mover exerts a force of 250 N on a rope of the pulley system and pulls the rope downward a distance of 4 m. The piano is raised a distance of 0.75 m. What is the efficiency of the pulley system? (IPC 4D)

D) 75%

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**Solution** The efficiency of a machine can be calculated from this equation:

$$eff(\%) = \frac{W_{out}}{W_{in}} \times 100\%$$

The pulley system lifts the piano 0.75 m by applying a resistance force of 1000 N to overcome the pull of gravity on the piano. So  $W_{out} = F \times d = 1000 \text{ N} \times 0.75 \text{ m} = 750 \text{ J}$ . The mover exerts a force of 250 N over a distance of 4 m and does work  $W_{in} = 250 \text{ N} \times 4 \text{ m} = 1000 \text{ J}$ . The efficiency, then, is  $(750 \text{ J}/1000 \text{ J}) \times 100\% = 75\%$ .

**6.** A student lifts a stack of books weighing 75 N from the floor to a table 1 m high. If it takes the student 2 seconds to lift the books, what power does the student use? **(IPC 4A)**  
**G)** 37.5 watts

**Solution** Power can be calculated by dividing the work done by the time over which the work is done, or:

$$P = \frac{W}{t}$$

In SI, work has the unit joule (J), time is in seconds (s), and the unit for power is the watt (W). The work done by the student is calculated by multiplying the force exerted on the books by the distance the books move in the direction of the force. Here the work done is  $75 \text{ N} \times 1 \text{ m} = 75 \text{ J}$ . The power then is  $P = (75 \text{ J})/(2 \text{ s}) = 37.5 \text{ W}$ .

**7.** An astronaut in space pushes against a satellite with a force of 50 N. The astronaut, in his spacesuit, has a mass of 100 kg, and the satellite has a mass of 500 kg. What is the acceleration of the astronaut immediately after he pushes on the satellite?  
**(IPC 4B)**  
**B)** 0.5 m/s<sup>2</sup>

**Solution** According to Newton's third law of motion, if the astronaut pushes on the satellite with a force of 50 N, the satellite pushes on the astronaut with a force of 50 N. The astronaut's mass is 100 kg, so that according to the second law of motion, the astronaut's acceleration is  $a = F_{net}/m = (50 \text{ N})/(100 \text{ kg}) = 0.5 \text{ m/s}^2$ .

**8.** An 70-kilogram student is standing on a chair. With what force is the chair pushing on the student? **(IPC 4B)**  
**J)** 686 N

**Solution** Because the student isn't moving, by the second law of motion the net force on the student is zero. The net force on the student is the combination of gravity pulling the student downward, and the chair pushing the student upward. So the force of the chair pushing upward must equal the force of gravity pulling downward. Earth's gravity pulls the student downward with a force equal to the student's weight, which equals  $(70 \text{ kg}) \times 9.8 \text{ m/s}^2 = 686 \text{ N}$ . This is equal to the upward force exerted on the student by the chair.