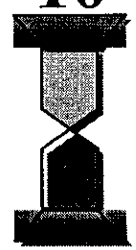
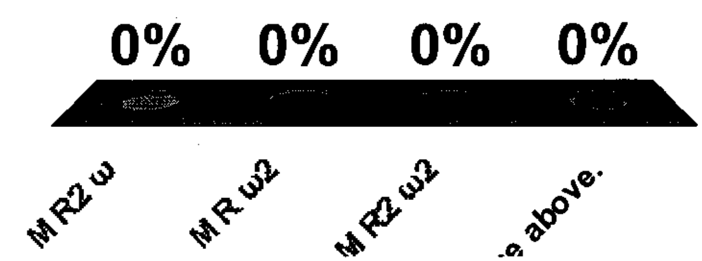
11/29/0‹ - 2

A certain space habitat is a cylinder of radius R, rotating about its symmetry axis at a rate ω. On its inside surface, the "equivalent gravity" force, has a magnitude equal to 10



1. $M R^2 \omega$
2. $M R \omega^2$ ✓
3. $M R^2 \omega^2$
4. None of the above.



# The correct answer is #2:

$$F_{G'} = M R \omega^2$$

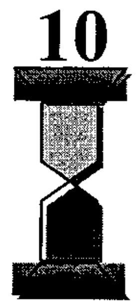
- The equivalent gravity force is just the centrifugal pseudo-force which must be be added to give Newton-II like behaviour in the rotating frame:

  $$F_{Pseudo} = v^2/R = R^2\omega^2/R = R\,\omega^2$$

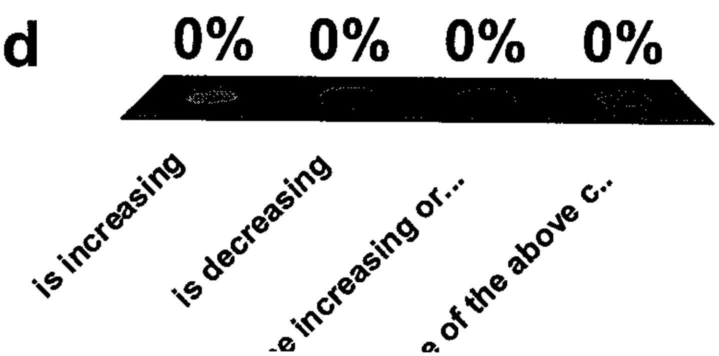
  (directed outward!...and so downward for the person standing on the inside surface of the cylinder.)
- One can also select the correct answer dimensionally: only $R\,\omega^2$ has the required dimension of acceleration: $L/T^2$.

11|29|06—1

A gas is expanding adiabatically (i.e., without any heat entering or leaving the gas) against the pressure of its container, performing work on the outside world as it does so. The temperature of this gas




1. is increasing
2. ✔ is decreasing
3. May be increasing or decreasing, depending upon the external pressure.
4. None of the above can be stated with certainty.

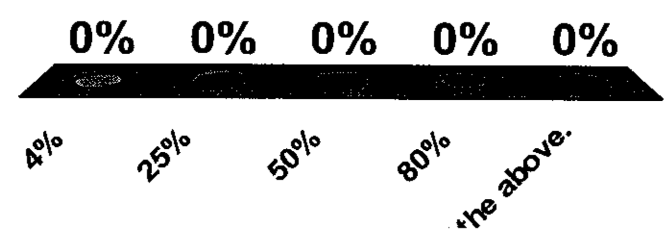


**The temperature of this gas is decreasing, because**

- Energy is leaving the gas in the form of work, and no energy is entering. Therefore $\Delta U_{INT} = W^{IN} = -|W^{OUT}| < 0$, (by 1st Law, see below*) is negative, and the internal energy is decreasing.
- Therefore the temperature is decreasing also.
- *(Recall 1st Law: $\Delta U_{INT} = W^{IN} + Q^{IN}$.)

A diesel engine's fuel burns at a maximum temperature of 2000 K and discharges exhaust at 400 K. Its efficiency can not be greater than

a) 4%
b) 25%
c) 50%
✔d) 80%
e) None of the above.

# The correct answer is d, because

- The ideal Carnot engine operating between the stated temperatures has in general, an efficiency equal to

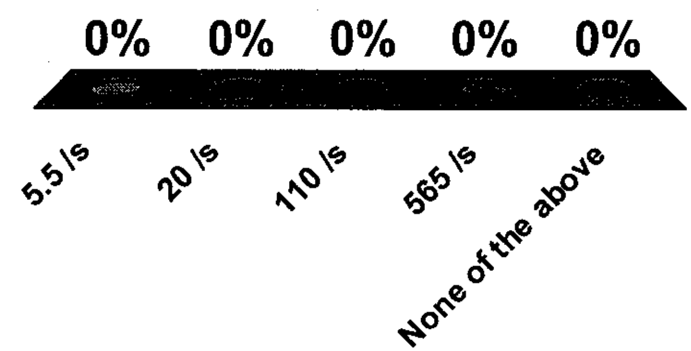
  $$\eta_{Carnot} = 1 - T_C/T_H \,.$$

- For the temperatures cited this efficiency has the value, 1- 400/2000 = 0.80 = 80%.
- But the Carnot engine is always more efficient than any other engine operating over the same temperature range.
- Therefore this diesel engine must have an efficiency $\eta_{Actual} < \eta_{Carnot} = 80\%$

12/11/06-X

**The wave speed in a certain fluid is 110 cm/s. If the distance between two successive peaks of a traveling wave is 5.5 cm, the frequency of the wave is**


a) 5.5 /s
✔b) 20 /s
c) 110 /s
d) 565 /s
e) None of the above



# The correct answer is b), $f = 20$ /sec

- Since $v = f^*\lambda$ for any traveling wave,
- It follows that

$$f = v/\lambda$$

$$= 110\text{cm}/5.5\text{cm-sec} = 20\ /\text{s}$$