Your Name: _____

Teammates: _____

Physics 8, Fall 2023, Worksheet #26.

`http://positron.hep.upenn.edu/p8/files/ws26.pdf`

Upload PDF (smartphone scan or tablet edit) to Canvas shortly after class on Mon, Dec 4, 2023.

Problems marked with (*) must include your own drawing or graph representing the problem and at least one complete sentence describing your reasoning.

Discuss each problem with your teammates, then write up your own solution. Be sure to compare final results with your teammates, as a way to catch mistakes. It can also be very interesting when you and a teammate use different methods to arrive at a result. Do not hesitate to ask for help from other students or from the instructors — but don't just copy down other people's results!

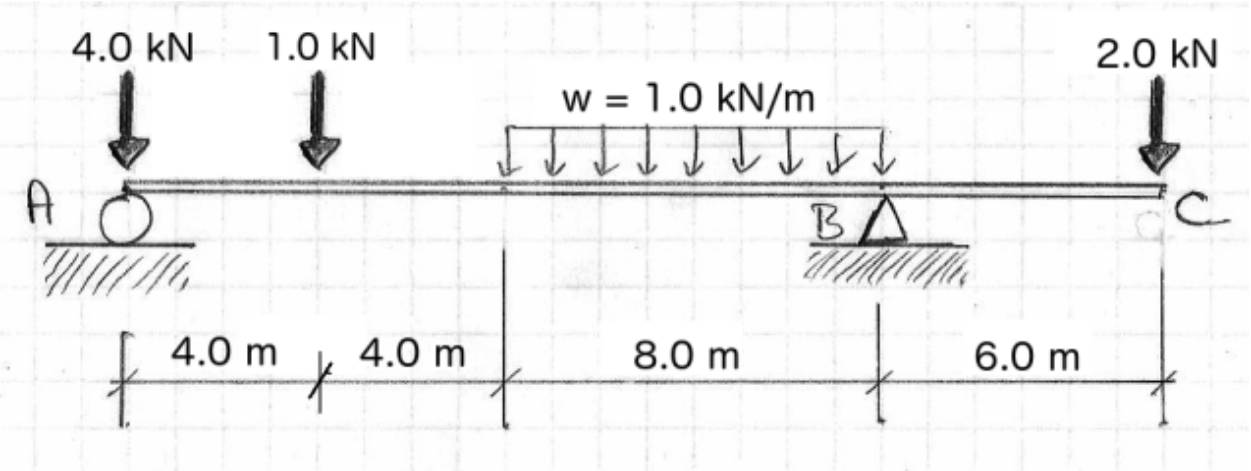
1. A simply supported beam (i.e. supported with a pin beneath one end and a roller beneath the other end) is 4.0 m long and carries two vertical (downward) point loads: 1.5 kN at distance 1.0 m from the left support and 2.5 kN at distance 2.0 m from the left support. (a) Draw the load diagram for the beam, including all vertical forces acting on the beam—both the load and the vertical support ("reaction") forces. (b) Beneath the load diagram, draw the shear diagram $V(x)$ for the beam. (c) Beneath the shear diagram, draw the bending-moment diagram $M(x)$ for the beam. (d) Comment on whether the beam is smiling or frowning and how this relates to the sign of the bending moment.

2. A simply supported beam is 4.0 m long and carries a uniformly distributed (downward) load of 1.0 kN/m. (a) Draw the load diagram for the beam, including all vertical forces acting on the beam—both the load and the vertical support ("reaction") forces. (b) Beneath the load diagram, draw the shear diagram $V(x)$ for the beam. (c) Beneath the shear diagram, draw the bending-moment diagram $M(x)$ for the beam. (d) What is the meaning of the $V(x)$ and $M(x)$ curves? For instance, if you were to section the beam a distance x from the left side, what would $V(x)$ and $M(x)$ tell you about the interactions (forces and torques) between the left and right sides of the section?

3. (a) When I hang a 15.0 kg mass from the end of a spring (the other end of which is attached to the ceiling), the spring stretches 1.25 m beyond its relaxed length. What is the spring constant k? (b) If I now pull the mass down a bit further and release it, what are the frequency (f, in hertz, i.e. cycles per second) and the period (T, in seconds) of the resulting periodic motion?

4. A 6.5 kg object is suspended from the ceiling by a strong spring, which stretches 0.18 m when the object is attached. The object is lifted 0.050 m from this equilibrium position and released. Find the amplitude and period of the resulting simple harmonic motion.

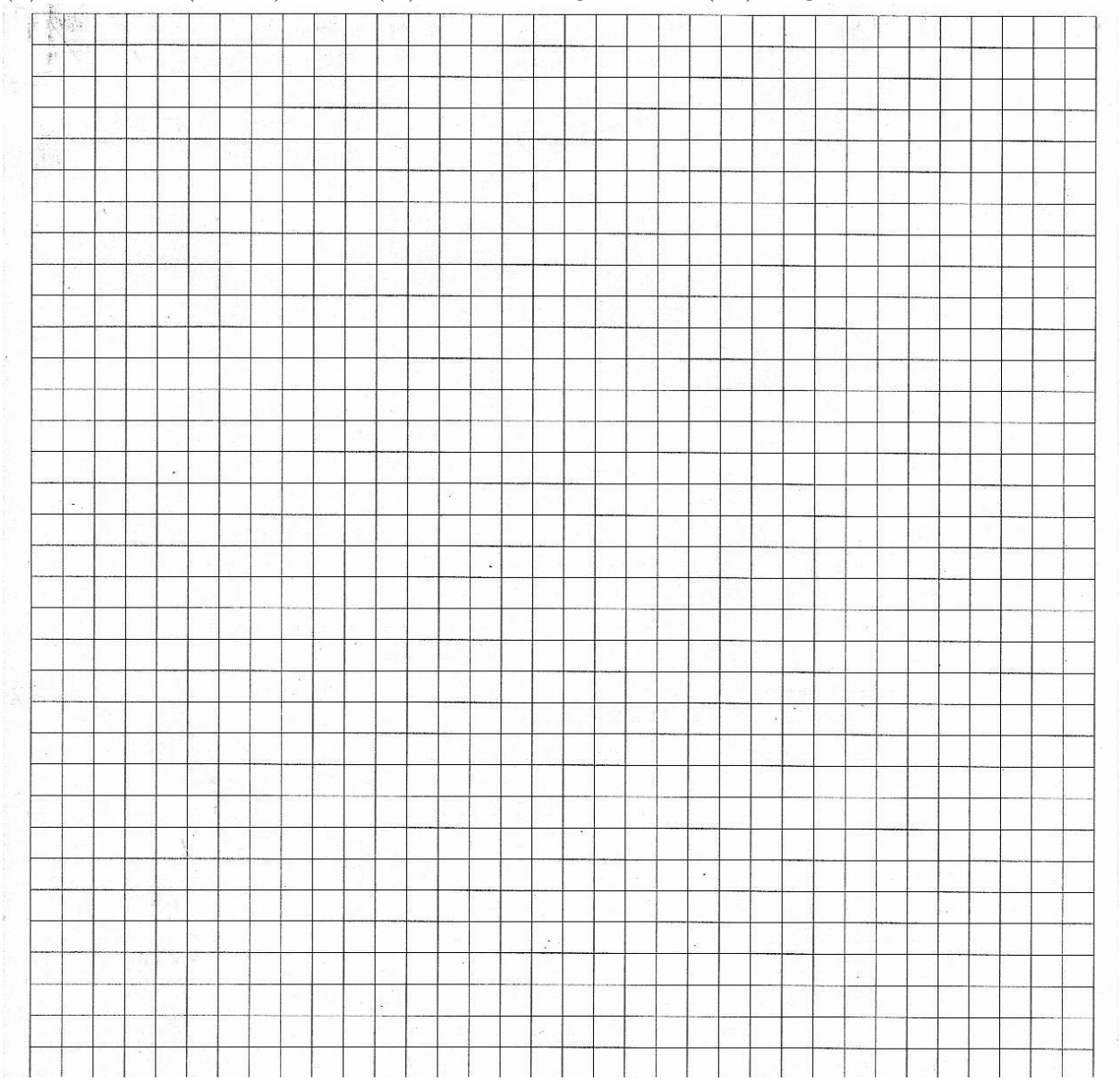
XC5*. (If you work this one out, I think even Prof Farley will be impressed! It is also a fun (I think) application of what I might call "graphical calculus." And see the end of this problem for a hint on what your graphs might look like. Also consider the online calculator at `www.bendingmomentdiagram.com` .) For the overhang beam shown below.



(a) Find the support forces A_y, B_x, and B_y exerted on the beam by supports A and B.

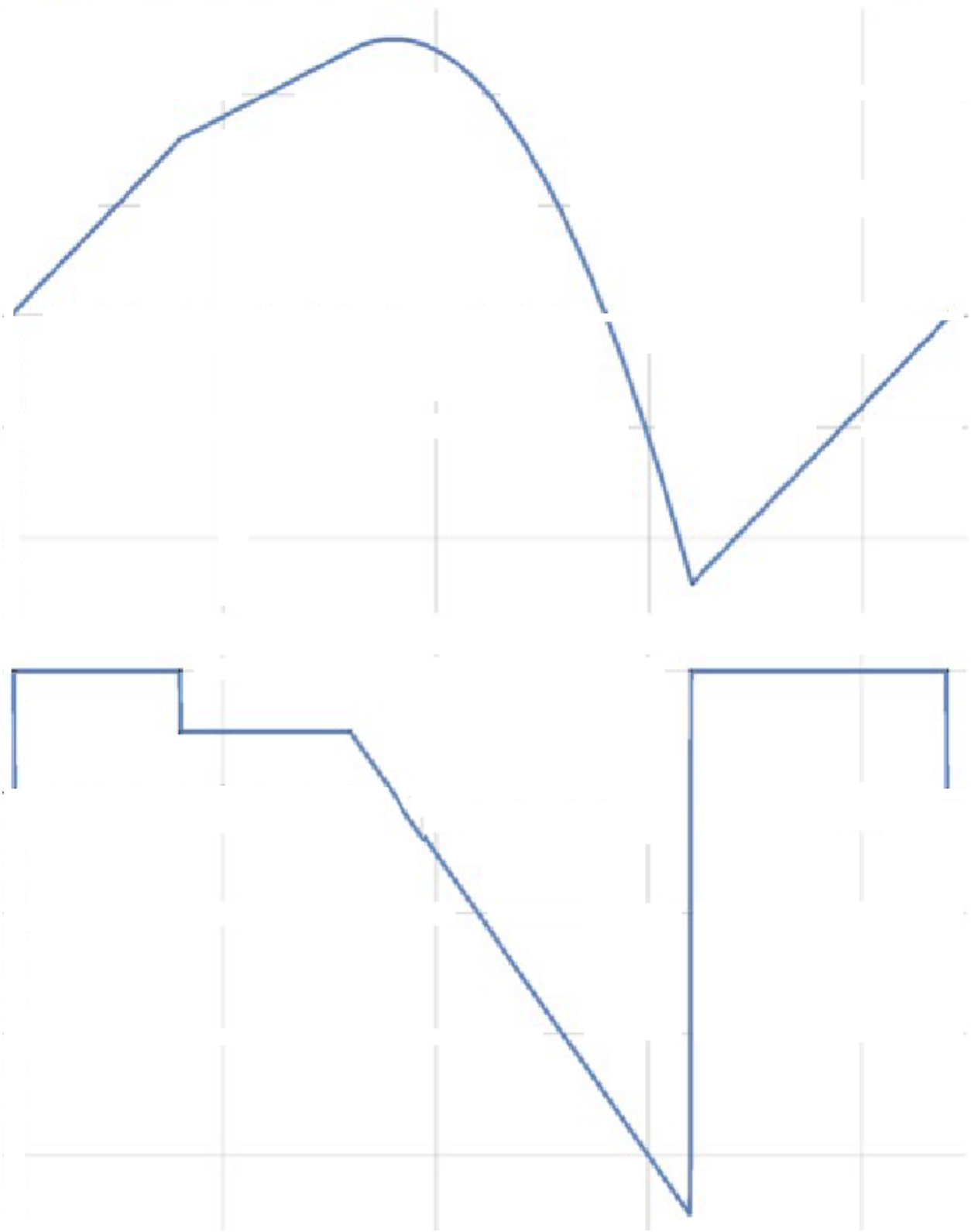
(Problem continues on next page.)

(b) Draw load (EFBD), shear (V), and bending moment (M) diagrams for the beam.

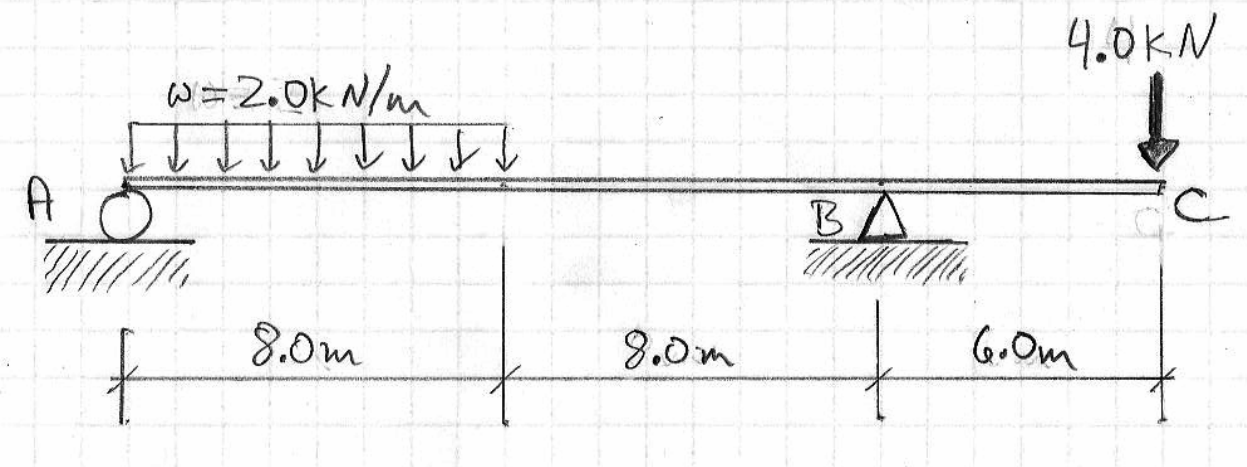


(c) What are the largest magnitude of the shear V (in kilonewtons) and the largest magnitude of the bending moment M (in kilonewton-meters)?

(I've tried to obscure my axes and grid lines a bit.)



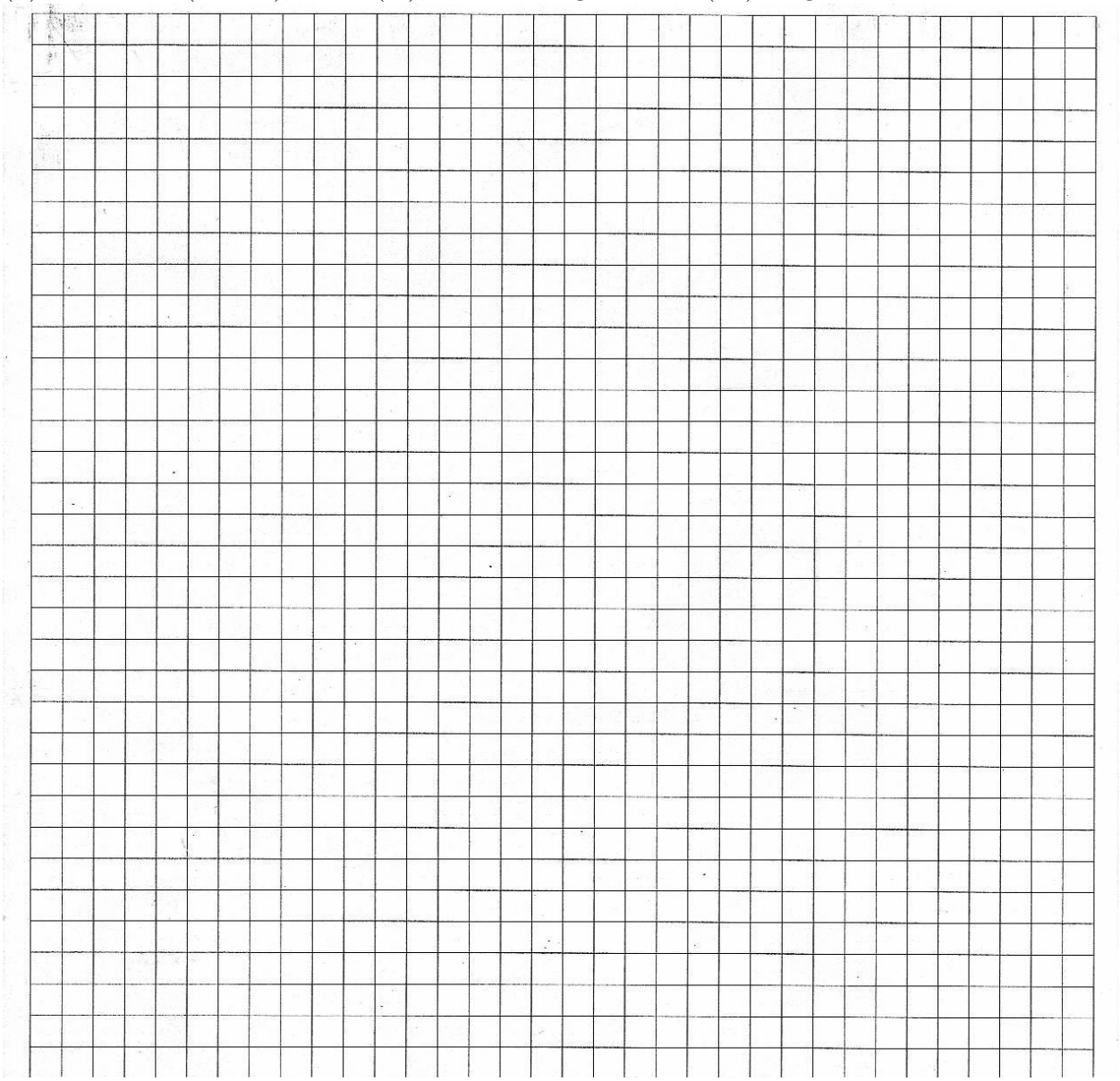
XC6*. For the overhang beam shown below.



(a) Find the support forces A_y, B_x, and B_y exerted on the beam by supports A and B.

(Problem continues on next page.)

(b) Draw load (EFBD), shear (V), and bending moment (M) diagrams for the beam.



(c) What are the largest magnitude of the shear V (in kilonewtons) and the largest magnitude of the bending moment M (in kilonewton-meters)?