# APPENDIX

Further suitable problems with solutions from the Macquarie University,
Higher School Certificate Problem Solving Course.

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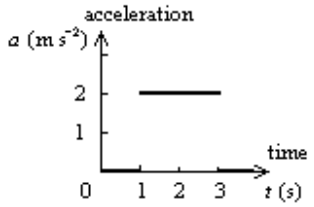
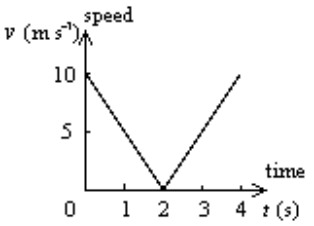
| 1. |  | A particle has an acceleration of 2.0 m $s^{-2}$ in the direction of its velocity between 1.0 and 3.0 seconds as indicated on the acceleration against time ($a$ vs $t$) plot. If the speed when t = 0 was $v_0$ = 5.0 m $s^{-1}$ what was the speed at $t$ = 2.0 s? What distance was covered by the particle between 0 and 3 seconds? |
| 2. |  | A particle travels in a straight line. Its speed with time is shown on the $v$ vs. $t$ plot.<br><br>Give the magnitude of the particle's acceleration at 1 and 3 seconds. Find the distance covered between 0 and 4 seconds. Hence (or otherwise) find the average speed of the particle over the 4 second interval. |

3. The displacement s (in metres) and the time t (in seconds) of an object travelling in a straight line is given below:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $s$ | 1.00 | 1.50 | 2.00 | 2.50 | 3.25 | 4.50 | 6.25 | 8.50 | 11.25 |
| $t$ | 0 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 |

Find the average speed for the first three seconds. Estimate the speed at 6.00 seconds? Find the average acceleration at 1.00 and 6.00 seconds.

4. A train passes a point at 18.0 m $s^{1}$ and returns later with a speed of 24.0 m $s^{1}$ in the opposite direction. If the train slows to a stop 310 m from the point with a uniform deceleration and instantly returns with uniform acceleration, find the initial deceleration and the subsequent acceleration. What is the time that the train takes to pass the point and return?

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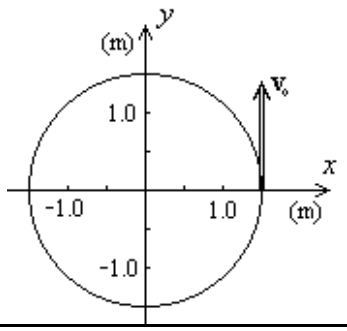
| 5. |  | A particle moves around a circle of 1.5 m radius with a constant speed of 5.0 m $s^{-1}$, what is the period of this circular motion? If the initial velocity, $\mathbf{v}_0$ is in the $y$ direction as shown at $t$ = 0, what is the velocity one quarter of a period later? Find the average acceleration for this quarter period. |

6. A bowler in a game of cricket bowls the ball in a horizontal direction 2.25 m above the cricket pitch. If the ball hits the ground 19.0 m along the pitch from the point of release, what is the speed of the ball and how long does it take from release to hitting the ground?

7. Plot the following velocity vs. time data for harmonic motion in a straight line. The velocity $v$ has units m $s^{-1}$ and the time $t$ is in seconds.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $v$ | 1.176 | 1.618 | 1.902 | 2.000 | 1.902 | 1.618 | 1.176 | 0.618 | 0 | -0.618 | -1.618 |
| $t$ | 0.000 | 1.000 | 2.000 | 3.000 | 4.000 | 5.000 | 6.000 | 7.000 | 8.000 | 9.000 | 10.000 |

Use your graph to determine the harmonic velocity and the period of the motion.

As $$a = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1}$$

plot successive intervals between $v$ to represent the harmonic acceleration, use this graph to determine the amplitude of the acceleration.

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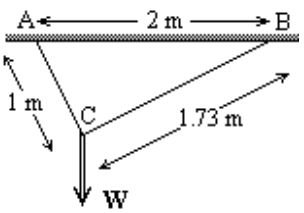
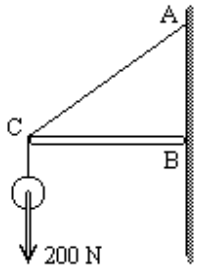
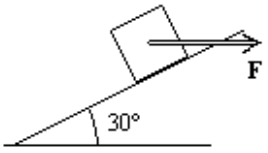
| 8. |  | A 50.0 kg mass is fastened to a rope so that it provides the force **W** as shown. Find the tension in AC and BC. If the knot at C is released so that the mass can slide freely but is still supported by the rope find the new equilibrium tension in the rope. |
| 9. |  | A 200 N weight force is supported by a 5.00 m wire AC and a 4.00 mrod BC, which acts as a prop and is held in place by friction.<br><br>Draw a diagram to show the forces which hold the 200 N force in equilibrium. Determine the magnitude of the forces that act along the wire and the rod. |
| 10. |  | A block of mass 2.00 kg is free to slide across the surface of a plane which is 30° from horizontal. No frictional forces act between the block and the plane. What is the magnitude of the horizontal force **F** which is required to hold the block stationary?<br><br>If the force **F** changes direction (but not magnitude) so that it acts down the plane on the block what is the acceleration of the block down the plane? |

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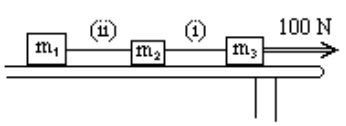
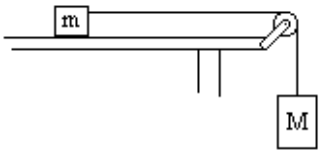
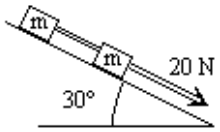
| 11. |  | Three masses<br>$m_1$ = 10 kg<br>$m_2$ = 2.0 kg<br>and $m_3$ = 5.0 kg<br>are free to slide without friction across the horizontal table.<br>If they are connected together by light unstitching cords and they are pulled by a horizontal force of 100N, find the acceleration of the three masses and the tension in the connecting cords (i) and (ii). |
| 12. |  | A mass m = 0.10 kg is pulled by a falling mass M = 10.0 kg . The larger mass M can fall without obstruction and the smaller mass m slides without frictional resistance across a horizontal surface. Find the acceleration of m. If the mass of M becomes large enough will m have an acceleration greater than g = 9.8 m $s^2$? |
| 13. |  | Two blocks each of mass m = 2.50 kg are joined together by a light incompressible rod which pulls the higher mass directly down the 30° slope. Both masses slide without frictional resistance.<br>If the lower mass is pulled by a force of 20.0 N directly down the plane find the acceleration of each block and the tension in the rod. |

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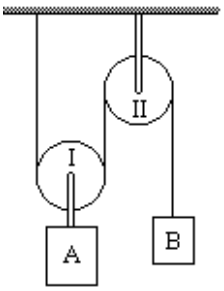
| 14. |  | In the block and tackle arrangement shown, two light pulleys I and II remain upright and can move without friction or inertia. A light non-stretching cord is passed around them. This cord is fastened to the ceiling, passes around I to support A and then around II and is fastened to B. The mass of A is 9.00 kg and the mass of B is 4.00 kg. Because of the connecting cord, if B moves up or down A will move half the distance down or up.<br><br>If we take g = 10.00 m $s^2$ the tension in the string is 43.2N. Find the acceleration of A and B, what total vertical force is required to support this accelerating system? |