1) The displacement of a ball is given by the following expression.

$s = 5t - 5t^2$

i) Calculate the velocity of the ball at t = 2 s.

ii) Calculate the acceleration of the ball.

iii) Draw a graph of the ball's displacement, for the first two seconds.

iv) Write down the gradient of a tangent to this curve at t = 2 s.

2. The velocity of a rocket is given by the expression

$v = 5t + 5t^2$

i) Draw a graph of the rocket's velocity for the first 4 seconds.

ii) Calculate the displacement of the rocket between 2 and 3 seconds.

iii) Calculate the acceleration of the rocket at 3 s.

3. A 15.0 cm spoke on a wheel undergoes an angular displacement of π in 2.0 s from rest.

i) Calculate the average angular velocity of the spoke.

ii) Calculate the average tangential velocity of a point on the edge of the spoke.

iii) Calculate the angular acceleration of the spoke.

iv) Calculate the average tangential acceleration of a point on the edge of the spoke.

v) If the acceleration is maintained for a further 2.0 s, then calculate the total angular displacement of the spoke from rest.

4. 40.0 kg child is on a merry go round that has an angular velocity of 0.5π $rads^{-1}$.

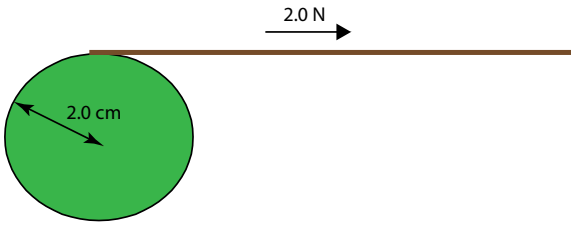
i) Calculate the centripetal acceleration of the child.

ii) Calculate the centripetal force acting on the child.

iii) Write down the unbalanced force acting on the child.

iv) What causes the centripetal force acting on the child?

5. A constant force of 2.0 N spins a 0.1 kg solid sphere of radius 0.02 m as shown. S



i) Calculate the acceleration of the sphere.

ii) The sphere undergoes a displacement of $\pi/10$ rad during the spin. Calculate the work done by the torque acting on the sphere.

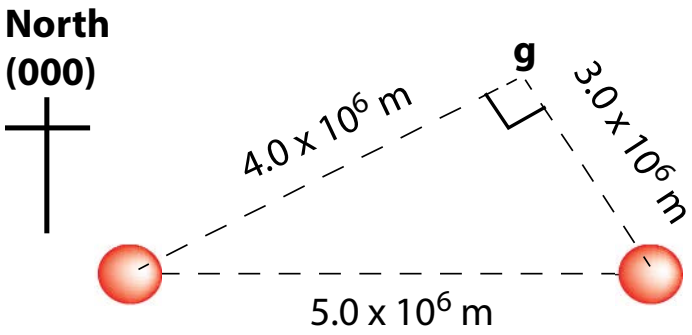
iii) Write down the gain in rotational kinetic energy of the sphere after this angular displacement.

iv) Assuming the sphere starts from rest, calculate the angular velocity of the sphere after this angular displacement.

v)

6. Explain why a ballerina rotates faster when she pulls her arms in. You may ignore any change in motion due to aerodynamics.

7. The diagram shows two planets of mass 6.0×10^{24} kg.



i) Calculate the gravitational field strength at g. Make the direction relative to the compass.

ii) Calculate the force on a space probe of 6.0×10^3 kg if positioned at g.

iii) Calculate the gravitational potential at g.

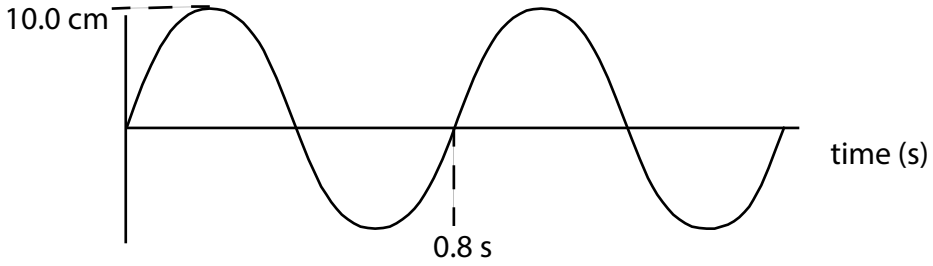
iv) Calculate the potential energy of a space probe of 6.0×10^3 kg if positioned at g.

v) How much energy is needed to take the space probe from g to infinity.

8. Calculate the escape velocity of Mars.

9. A solid sphere of allowed to roll down a slope of height 7.0m. Show that the velocity of the ball at the bottom of the slope is 9.9 ms^{-1}.

10. The displacement – time graph of a 50.0 g pendulum is shown below.



(A) Copy out this graph and below it draw

i) The velocity – time graph for the pendulum

ii) The acceleration -time graph for the pendulum.

(B)

i) Write down the magnitude of the maximum velocity of the pendulum and where it occurs.

ii) Write down the magnitude of the maximum force acting on the pendulum and where it occurs.

iii) What causes the force acting on the pendulum.

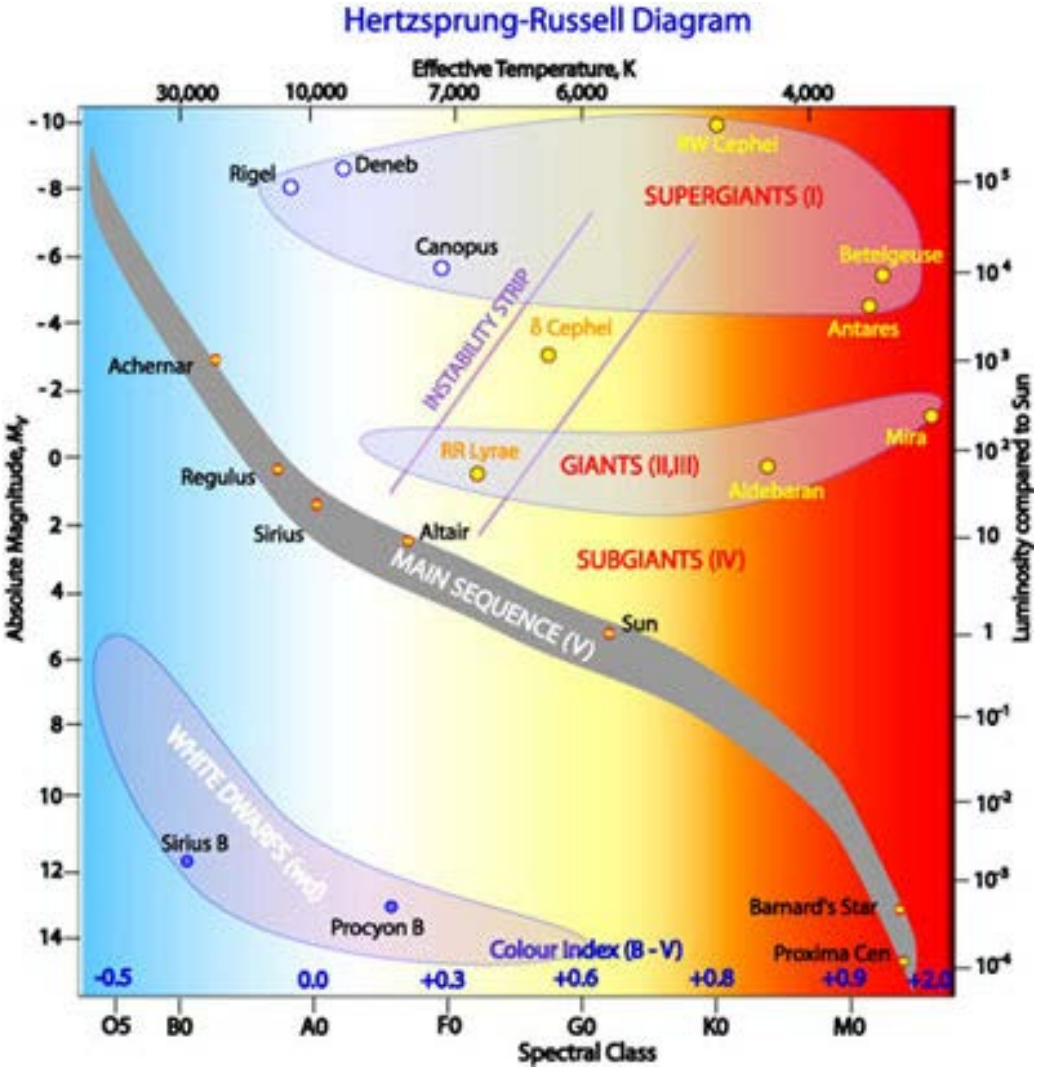
11. The power radiated per unit area of a black body is proportional to the fourth power of its temperature.

i) State the constant of proportionality in this law and name it.

ii) Suppose star A and star B are identical in size but the surface temperature of star B is twice that of star A. How much more luminous than Star A will star B be?

iii) Suppose star C and star D are identical in luminosity but the surface temperature of star C is twice that of star D. How much more than Star D is the radius of star C?

12. Consider the H-R diagram.



(A)

The surface temperature of proxima centauri is approximately the same as Betelguese but the luminosity of Betelgeuese is 10^9 greater, however the luminosity of Canopus is approximately the same as Betelgeuese but considerably hotter. Also the Sun is clearly the brightest star in the sky but according to this graph it is less luminous than Sirius (and all stars above the Sun on the graph).

i) Account for the Betelgeuese- Proxima Centauri observation.

ii) Account for the Betelgeuese- Canopus observation.

iii) Account for the Sun-Sirius observation.

(B)

The radius of Betelguese is approximately 820.0 x 10^9 m. Using this value and the HR diagram above,

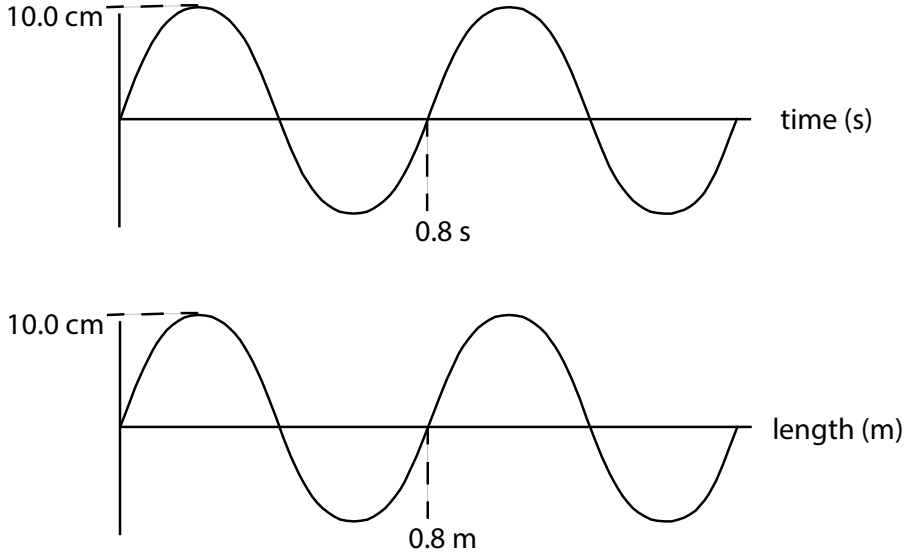
i) Calculate the approximate radius of proxima centauri,

ii) Calculate the approximate radius of Canopus,

13. A travelling wave moving to the right can be written as

$y = Asin2\pi f\left(x - \frac{t}{v}\right)$ *or* $y = Asin2\pi(\frac{t}{T} - \frac{x}{\lambda})$.

The two wave representations below represent the time and distance dependence of the same wave.



Write the travelling wave equation for this wave in the two forms above.

14. What is meant by the 'ultraviolet catastrophe' and what was its significance for the development of modern physics?