Section 2: Applying Newton's second law

Exercise level 2

1. Jack and Jill went up the hill to fetch a pail of water. The pail had a mass 5 kg when empty and 15 kg when full. The pail was lowered into the well at a constant acceleration of 4 m s^{-2}. When the pail was full it was raised at a constant speed 3 m s^{-1}.
   Neglecting the weight of the rope, find the tension in the rope
   (i) when the pail was being lowered,
   (ii) when the full pail was being raised.

2. A lift descends with an acceleration of 1.5 m s^{-2}, then moves at a constant speed until it is decelerated at 1 m s^{-2}. A package of mass 20 kg stands on the floor of the lift during the journey. Find the magnitude of the force it exerts on the floor of the lift at each stage.

3. Two forces of $5\mathbf{i} + 2\mathbf{j}$ and $\mathbf{i} - 3\mathbf{j}$ act on a particle of mass 2 kg which is initially moving at a velocity of $\mathbf{u}$.
   (i) What is the acceleration of the particle?
   (ii) The particle comes to rest after 4 seconds. Find u.

4. A vehicle of mass 2000 kg is travelling along a straight horizontal road at 90 km h^{-1}. It is brought to rest in a distance of 500 m by a force of magnitude *P* Newtons. Find *P* and the time taken to come to rest.

5. A coalminers' cage of mass 450 kg contains four coalminers of total mass 300 kg. The cage is lowered from rest by a cable. For the first 12 seconds the cage accelerates uniformly and descends a distance of 96 m.
   Find the force in the cable during the first 12 seconds.

6. A particle P with mass 5 kg is initially at the point (3, 2) and has velocity $\begin{pmatrix} 1 \\ -2 \end{pmatrix}$. A force acts on the particle and after 2 seconds it is at the point (2, -1). Find the force.

7. A balloon of total mass 420 kg is descending with constant acceleration of 0.4 m s^{-2}.
   (i) Find the upthrust acting on the balloon.
   When the balloon is moving at 1.5 m s^{-1}, enough ballast is released for the balloon to fall with a deceleration of 0.2 m s^{-2}. Assuming that the upthrust remains the same, calculate
   (ii) how much ballast was released
   (iii) the time for which the balloon continues to fall before it begins to rise

8. A load of 200 kg is lifted through 50 m by a vertical cable. The load accelerates uniformly from rest for 20 seconds, travels at constant speed for 10 seconds then decelerates to rest in a further 10 seconds. Find the maximum speed attained and the tension in the cable at each stage.