Solution 1

(4 marks)

During a chase scene in a movie, an actor drops onto the top of an elevator that is descending at a constant speed of 1.00 m s^{-1}. The time taken to land on top of the elevator is 6.10×10^{-1} s. Determine the distance in metres the elevator is below the actor when she starts her drop. Show **all** workings.

Description	Marks
Distance travelled by elevator: $s = (v \times t)$ $= 1 \times 0.610 = 0.610$ m	1
Distance travelled by hero $s = ut + ½ at^2$ $s = 0 + 0.5 \times 9.8 \times t^2$ $s = 1.82$ m	1–2
distance below = 1.82-0.61 = 1.21 m	1
Total	**4**

Solution 2

(4 marks)

Bathroom scales measure weight (a force) but give the reading in kilograms (mass). A particular scale shows a person's mass as being 70 kg at the Earth's equator. The spinning of the Earth contributes to the scale's reading. What would the scale read at the South Pole, with the same person standing on it? (Circle the correct answer.)

the same less than 70 kg more than 70 kg

Explain your reasoning:

Description	Marks
'More than 70 kg' circled	1
Part of the gravitational force is used to provide centripetal force at the equator $F_g = F_w + F_c$ The centripetal force is zero at the poles so the weight force is correspondingly larger	1–3
OR The Earth is not spherical. You are slightly closer to the Earth's centre at the poles so the gravitational force is slightly larger at the poles, hence weight is larger at the poles.	1–2
	Total 4

Solution 3

(3 marks)

Annie carries a suitcase into a lift. As the lift starts to move, she feels the suitcase change weight and feel lighter. Explain how she can tell which way the lift is moving.

Description	Marks
When the lift starts to move, it undergoes acceleration.	1
She is feeling the resultant force (weight) due to the combination of the acceleration of the lift and gravitational acceleration acting on the mass	1
For the bag to feel lighter, the lift needs to be accelerating in the direction of the weight force (down).	1
Total	**3**

Solution 4

(3 marks)

Pat has a mass of 62.0 kg. Calculate Pat's weight. Include the correct units in your answer.

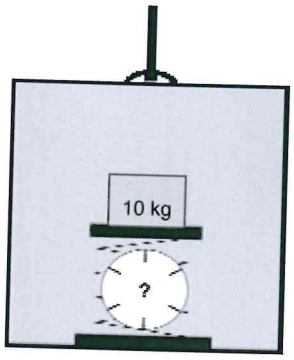
Description	Marks
$F = mg = 62 \times 9.8$	1
608	1
N	1
Total	**3**

Solution 5

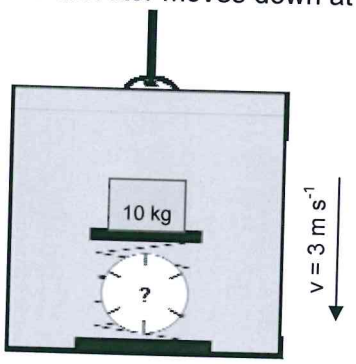
(11 marks)

An experiment is conducted in which an object with a mass of 10 kg is placed on a scale sitting on the floor of an elevator, as shown in the diagrams below. Assuming the local gravity is 9.8 m s^{-2}, estimate the reading of the scale in newtons when

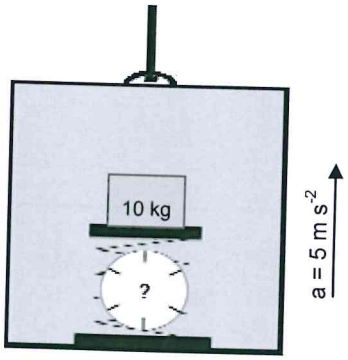
(a) (i) the elevator is stationary; (1 mark)



(ii) the elevator moves down at a constant velocity; (2 marks)



(iii) the elevator accelerates up at a constant acceleration. (2 marks)

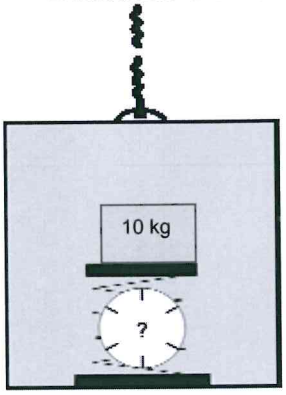


Description	Marks
(i) $W = mg = 10 \times 9.8 = 98$ N	1
(ii) Recognise a = 0	1
= 98 N	1
(iii) $W = m(g-a) = 10 \times (9.8 + 5)$	1
= 148 N	1
	Total 5

Solution 5 cont

(b) During the experiment, while the elevator was accelerating up at a constant acceleration, the cable suddenly broke and the elevator began to fall freely.

(i) Determine the new scale reading. (2 marks)



(ii) The elevator was moving upward at 5.30 m s^{-1} when the cable broke. It took 1.50 s to reach the ground. How high above the ground was the elevator when the cable broke? (2 marks)

Description	Marks
(b) (i) $W_{after} = 10 \times 0$	1
= 0 N (Goes from 148 N to zero – no reaction force between the scales and the lift – explanation not necessary.)	1
(ii) $s = ut + \frac{1}{2} at^2 = 5.3 \times 1.5 + \frac{1}{2} (-9.8) \times (1.5)^2$	1
= -3.075 m	1
	Total 4

(c) Modern elevators are equipped with speed governors that apply a braking friction when a maximum speed is exceeded. These brakes bring the elevator slowly to a stop. Explain why it is desirable for the elevator to be brought to a stop slowly rather than quickly. (2 marks)

Description	Marks
The change in momentum is constant, Ft=m(v-u)=constant May use $F = \Delta p/t$	1
Increasing the time (slowly) decreases the force on the occupants	1
	Total 2