Chapter 3: Dynamics (Newton's Laws of Motion) Solutions

1 Apply Newton's 2nd law to the horizontal motion of the system of three blocks:

$F = (\text{total mass of system})\,a = (2+3+4)(2) = 18$ N

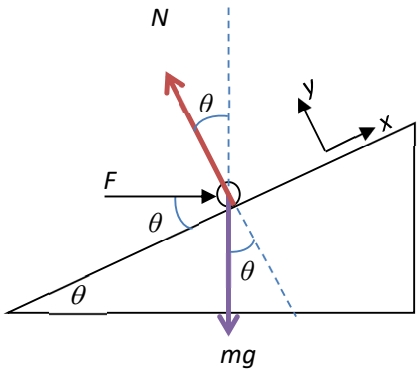
Next, apply Newton's 2nd law to the horizontal motion of the 4 kg block:

$F - T = (4)a = (4)(2)$

$\Rightarrow T = 18 - 8 = 10$ N

ANS: C

2



Using the coordinate system shown,

the resultant force along the *y* direction is zero: $F_y = N - F\sin\theta - mg\cos\theta = 0$

the resultant force along the *x* direction is: $F_x = F\cos\theta - mg\sin\theta$

ANS: A

3 Consider all the masses together, and let *N* be the normal contact force from floor of lift on the 5*M*:

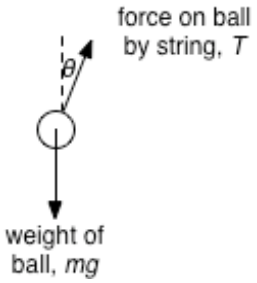
$N - 9Mg = (9M)\,a$
$N = 9Ma + 9Mg$

Consider forces acting on the 5*M* mass and let *R* be the force *M* exerts on 5*M* :

$N - 5Mg - R = (5M)\,a$
$R = N - 5Mg - 5Ma$
$= (9Ma + 9Mg) - 5Mg - 5Ma$
$= 4\,Ma + 4\,Mg$

ANS: C

4 **(a)**



(b) Rock : $(10)(9.81) - T = 10\,a$
Box and ball: $T = (35)\,a$

Adding the two equations: $(10)(9.81) = (10+35)\,a$
$a = 2.18\ \text{m s}^{-2}$

Ball : $T \sin\theta = ma$
$T \cos\theta = mg$
Dividing the two equations : $\tan\theta = a / g = 2.18 / 9.81$
θ **= 12.5 °**

(c) The maximum angle is **45°** when the acceleration of the system of rock, box and ball is at its maximum value of 9.81 m s^{-2}. This value of acceleration can occur if the mass of the rock is very large compared to the mass of the box and ball. (refer to working in **(b)** : $m_{rock}\,g = (m_{rock} + m_{box} + m_{ball})\,a$

$$\tan\theta = \frac{g}{g} = 1$$

$$\theta = 45°$$

5 **(a)** **(i)** Consider forces along the slope:
$F_1 \cos 30° = (40)(9.81) \sin 30°$
F_1 = **227 N**

(ii) consider forces perpendicular to slope:
$N = F_1 \sin 30° + (40)(9.81) \cos 30°$ = **453 N**

(b) $F = ma$
$(40)(9.81) \sin 30° = 40\,a$
a = **4.91 m s^{-2}**

(c) If friction is not negligible: $F_1\cos 30^0$ + friction = $mg\sin 30^0$.
Thus to maintain equilibrium, the value of F_1 will be smaller.