Additional Topic 2 answers

Topic 2 Mechanics

2.1 Motion

1 **a** $1.67\,km\,h^{-1}$
b $1.2\,km\,h^{-1}$ at 34° east of south

2 **a** 88 m
b 68 m
c $8.33\,m\,s^{-1}$; $5.0\,m\,s^{-1}$

3 **a** $1.7\,m\,s^{-1}$
b $-6.0\,m\,s^{-1}$

4 4.0 s

5 3.0 s

6 **a** 1.2 s
b 3.7 s
c 22 m
d $9.3\,m\,s^{-1}$
e 29 m

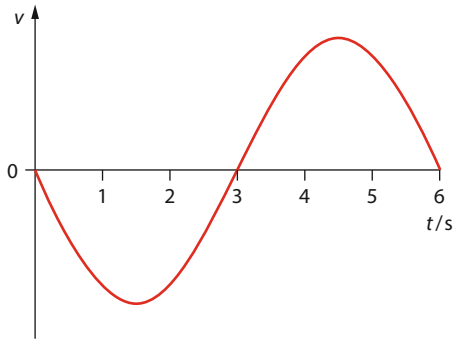
7 **a** 4.37 s
b $32.9\,m\,s^{-1}$
c 60.2 m

8 **a** 1.8 s
b $23\,m\,s^{-1}$

9 0.326 s

10 $-14.6\,m\,s^{-1}$

11



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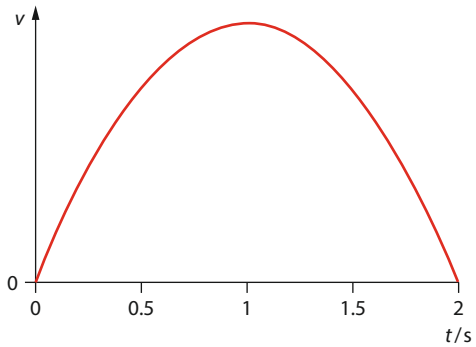

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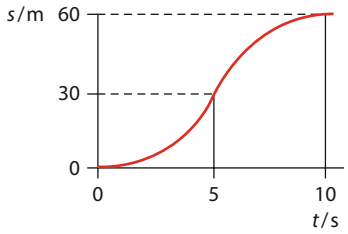
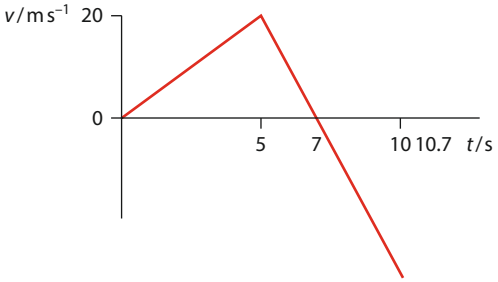


14 Make graphs of position against time; the graphs must cross.

16 **a** 70 m
b 10.7 s from the start
c



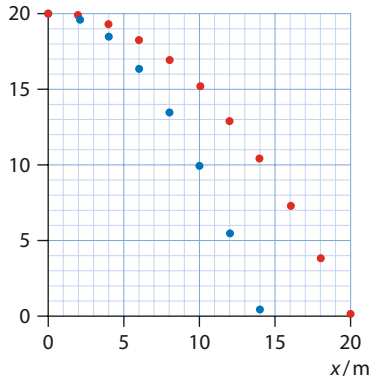
17 **a** 0.78 s
b $9.2\,m\,s^{-1}$

18 **a** 2.0 s
b $13\,m\,s^{-1}$
c −51°
d $21\,m\,s^{-1}$ at −68°

19 320 m

20 52° below the horizontal

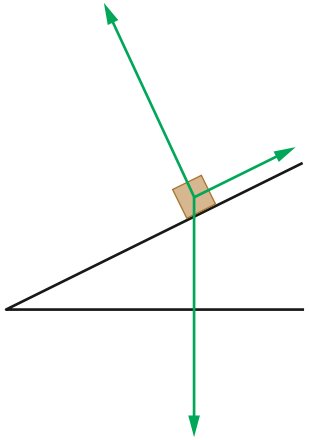
21 **a** $10\,m\,s^{-1}$
b



22 $18\,m\,s^{-1}$ at 58°

2.2 Forces

24



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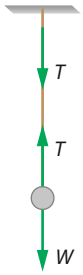
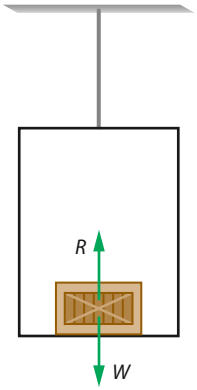


26 143 N

27



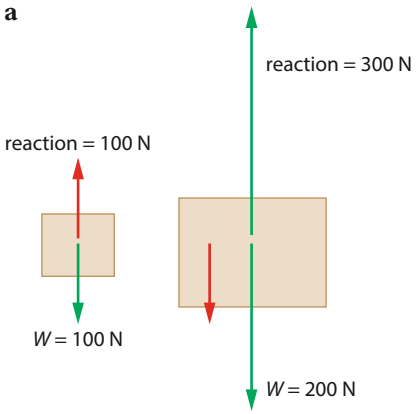
28 7.6 N at 58°

29 5.57 N at 162°

30 4.89 N

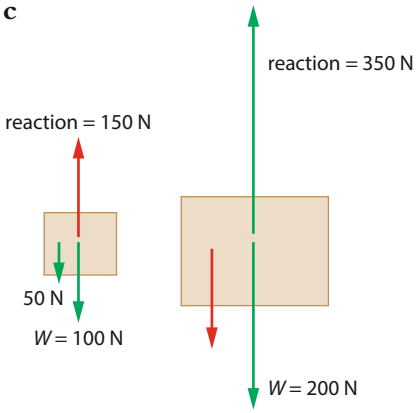
31 62.5 N

32 **a**



b Forces in red are an action–reaction pair.

c



33 **a** 1220 N

b 4040 N

34 < AQ: This is not the right answer: should be T_1, T_2 and T_3>

35 7.00 m s^{-2} and 3.00 m s^{-2}

36 **a** mg

b mg

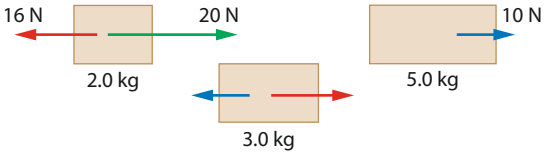
c greater than mg

d less than mg

e mg

37 94 N

39 **a** see free-body diagrams (vertical forces are excluded)



b forces in the same colour are action–reaction pairs

40 **a** **i** 39 N **ii** 55 N

b 59 N in **i** and 83 N in **ii**

2.3 Work, energy and power

41 **a** Work done by weight and reaction force is zero. Work done by F is 240 J and by friction is −168 J.

b 72 J

c The kinetic energy increases by 72.0 J.

42 **a** −1900 J

b +1900 J

c z ero

43 0.49 m s^{-1}

44 7.7 m s^{-1}; 12 m s^{-1}

45 3.0×10^2 W

46 $F \propto v^2$

47 a The potential energy the mass has at the top is converted into kinetic energy. As the mass lands, all its potential energy has been converted to kinetic energy.

b Some of the initial potential energy has been converted to kinetic energy. The kinetic energy remains constant during the fall. The remaining potential energy decreases as the mass falls and gets converted into thermal energy. As the mass lands, all the initial potential energy gets converted into thermal energy (and perhaps a bit of sound energy and deformation energy during impact with the ground).

c The kinetic energy remains constant. The potential energy is increasing at a constant rate equal to the rate at which the pulling force does work.

48 a 2900 N

b 5.8 kW

c 500 N

d 2.0 kW

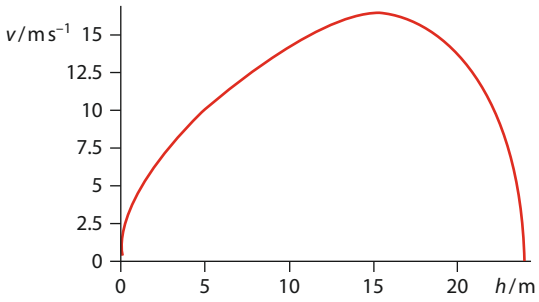
e 700 N

49 a $200\,\text{N}\,\text{m}^{-1}$

50 a $15\,\text{m}\,\text{s}^{-1}$

b $16\,\text{m}\,\text{s}^{-1}$

d



2.4 Momentum and impulse

51 $7.00\,\text{m}\,\text{s}^{-1}$

52 a $-5.00\,\text{N}\,\text{s}$

b 25.0 N

54 a yes

b no

55 b The order of magnitude is about 10^{-23} m.

56 5.05 N s at 56.3°

57 ratio of light to heavy = 2

58 b 38 400 N on both

c 4800 N s

d The force would be larger but the impulse would be the same.

e 4000 J; the final kinetic energy is 10 000 J

59 27 J

60 a There are no external forces on the binary star system.

b The momentum of the system is not just constant but also zero; otherwise it would change direction as the stars moved. Hence the stars must have opposite momenta, i.e. they have to be diametrically opposite each other.

c Since they are opposite each other at all times, they complete orbits in the same time.

61 a $0.71\,\text{m}\,\text{s}^{-1}$

b $0.77\,\text{m}\,\text{s}^{-1}$