National 5 Physics

Dynamics and Space

Answer Book

DO NOT WRITE
ON THESE SHEETS

Velocity and Displacement

Vectors and Scalars

1. Vectors have magnitude and direction, scalars have magnitude only.

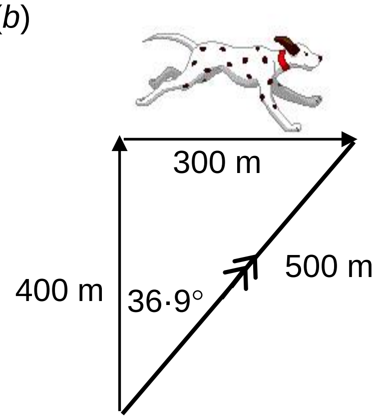
2.

	Quantity	*Vector or Scalar*
(*a*)	force	vector
(*b*)	speed	scalar
(*c*)	velocity	vector
(*d*)	distance	scalar
(*e*)	displacement	vector
(*f*)	acceleration	vector
(*g*)	mass	scalar
(*h*)	weight	vector
(*i*)	time	scalar
(*j*)	energy	scalar

3. (*a*) 250 m
(*b*) 150 m to the right.

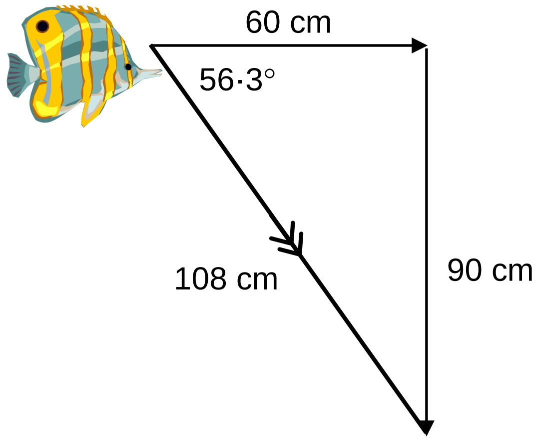
4. (*a*) 410 m
(*b*) 250 m to the right.

5. (*a*) 700 m
(*b*)

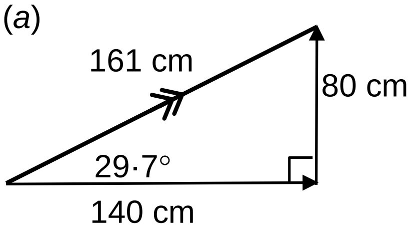


6. (*a*) 150 cm

(*b*)



7. (*a*)



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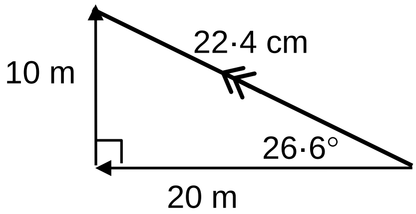

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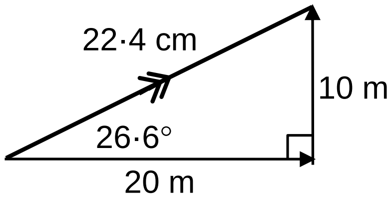

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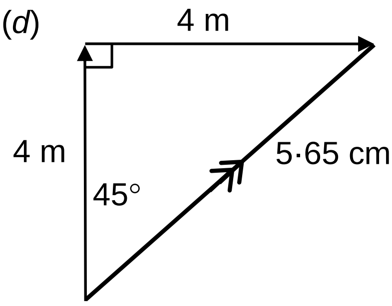

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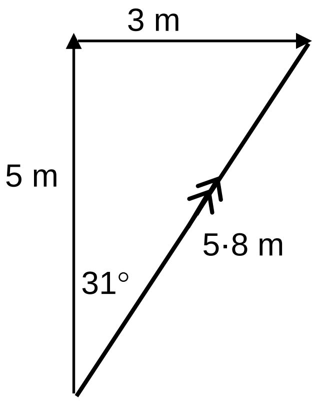

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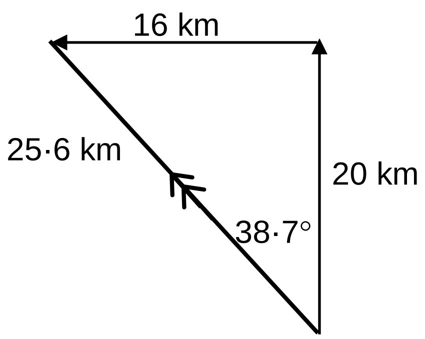
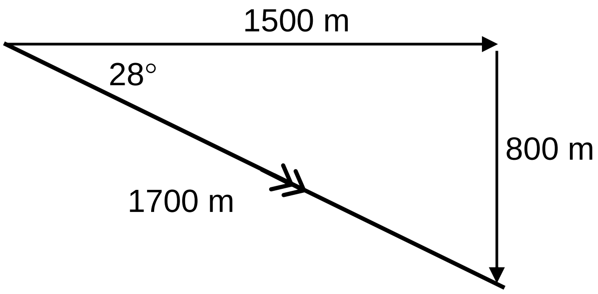


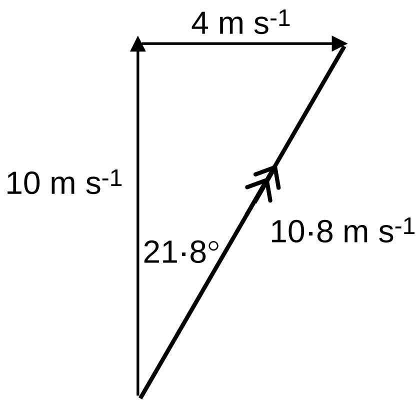
10. (*a*) 2300 m

(*b*)



11. 130 m s^{-1} forwards.

12.



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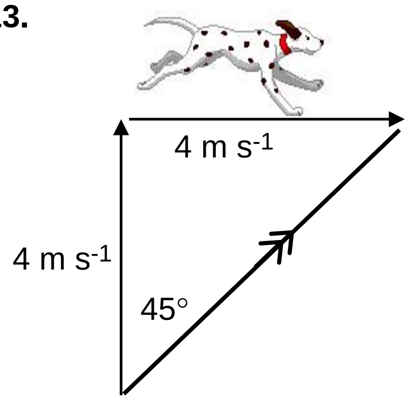

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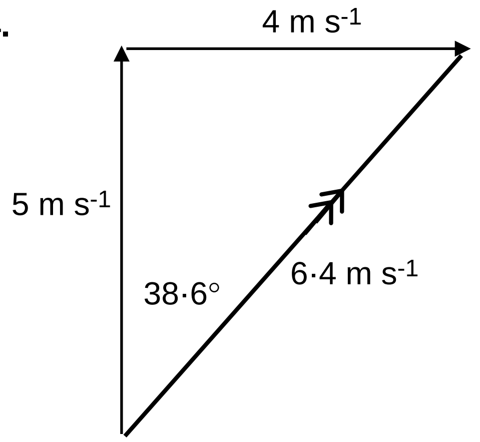
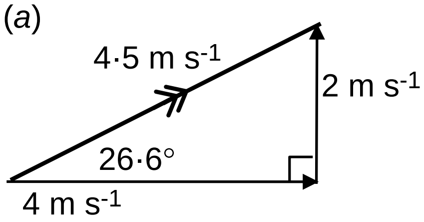
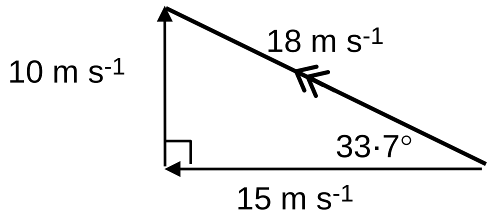


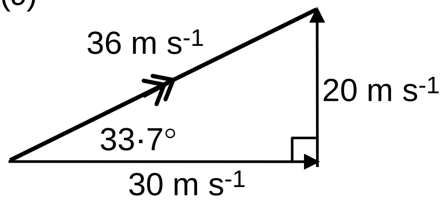
15. (*a*)



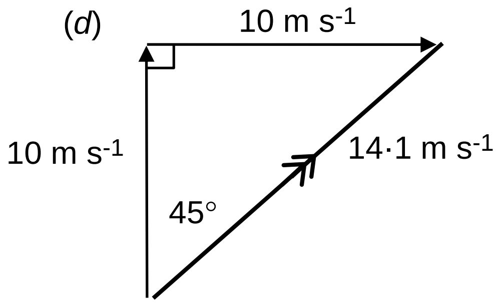
(*b*)



(*c*)



(*d*)



16. 2·6 m s^{-1} at 16·7° to the right.

17. 19·3 m s^{-1} at 21·3° to the east.

18. 4·03 m s^{-1} at 60·3° to the east.

Average and Instantaneous Speed

19. A Average
B Instantaneous
C Instantaneous
D Instantaneous
E Average

20. Measure the length of the track to find the distance she runs. Someone stands at the finish line with the stopwatch. When the race is started the stopwatch is started and stopped when the girl crosses the finish line. Speed is calculated from the distance of the race divided by the time the runner took.

21. $d = v \times t$ or $v = \frac{d}{t}$

22. (*a*) 2·5 m s^{-1}
(*b*) 50 m s^{-1}
(*c*) 15 s
(*d*) 30 s
(*e*) 960 m
(*f*) 36 m

23. 0·8 s

24. (*a*) 14·3 m s^{-1}
(*b*) 800 s

25. 33·3 m s^{-1}

26. 480 m s^{-1}

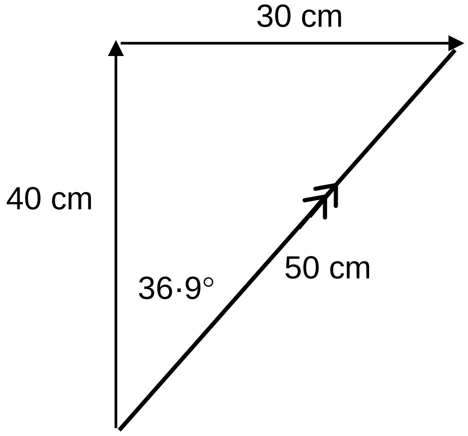
27. 36 000 m (36 km)

28. 0·75 hours or 45 minutes.

Extension Questions

29. (*a*) (i) 160 m
(ii) 4·57 m s^{-1}
(*b*) (i) 80 m forwards along the track.
(ii) 2·3 m s^{-1} forwards along the track.
(*c*) (i) 0 m
(ii) 0 m s^{-1}

30. (*a*) (i) 70 cm
(ii) 10 cm s^{-1}
(*b*) (i)



(ii) 7·1 cm s^{-1}

Speed-Time Graphs

31. B rest,
D travelling at a constant speed,
A slowing down,
C speeding up.

32. (*a*) (i) 3 m s^{-1}
(ii) 9 m s^{-1}
(*b*) 48 m

33. (*a*) 0-10 s cyclist accelerates, 10-40 s cyclist travels at a constant speed.
(*b*) 140 m
(*c*) 3·5 m s^{-1}

34. 40 m

35. (*a*) Accelerates for 40 s then slows down for 10 s.
(*b*) 125 m

Light Gates and Acceleration

36. The vehicle passes through the light gate. As it does so the card blocks the beam of light to the photocell. The computer measures the time the light is blocked. Speed can be calculated from the length of the card divided by the time the beam is blocked.

37. (*a*) $\text{acceleration} = \dfrac{\text{final speed - initial speed}}{\text{time taken for change}}$ or $a = \dfrac{v - u}{t}$

(*b*) The two cards give two speeds, an initial speed and a final speed. The computer also records the time interval between the two cards passing through the light gate.

(*c*) The single card gives an initial speed as it passes through the the first light gate and a final speed as it passes through the second light gate. The time between passing through each light gate is also recorded by the computer.

38. $v = u + at$

39. (*a*) 4 m s^{-2}
(*b*) 5 m s^{-2}
(*c*) 100 m s^{-1}
(*d*) 35 m s^{-1}
(*e*) 30 m s^{-1}
(*f*) 20 m s^{-1}
(*g*) 11 s
(*h*) 5 s
(*i*) –2 m s^{-2}
(*j*) 20 m s^{-2}

40. 22·2 m s^{-2}

41. 14 m s^{-1}

42. 200 s

43. (*a*) 0·5 m s^{-2}
(*b*) 100 s

Acceleration Graphs

44. 0·25 m s^{-2}

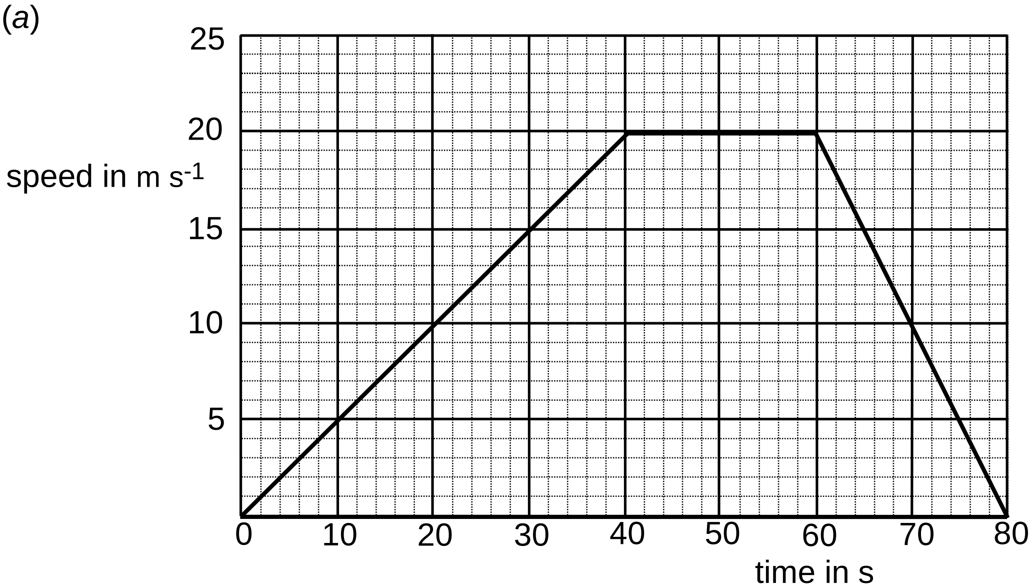
45. (*a*) 0·625 m s^{-2}
(*b*) –1·25 m s^{-2}

46. (*a*) 20 m s^{-2}
(*b*) 6·7 m s^{-2}
(*c*) –40 m s^{-2}

Extension Questions

47. (*a*) (i) 0·75 m s^{-2}
(ii) 0 m s^{-2}
(iii) 1 m s^{-2}
(iv) –2·5 m s^{-2}
(*b*) 28 m

48. (*a*)



(*b*) 0-40 s - 5 m s^{-2}, 40 – 60 s - 0 m s^{-2}, 60 – 80 s - –1 m s^{-2}
(*c*) 1000 m
(*d*) 12·5 m s^{-1}

49. (*a*) A to B – accelerates, B to C – slowing down or negative acceleration.
(*b*) B
(*c*) 4·8 m
(*d*) 4·5 m s^{-1}
(*e*) A to B 10 m s^{-2}, B to C –20 m s^{-2}

50. (*a*) (i) 3 m s^{-1}
(ii) 4 m s^{-1}
(*b*) Skipper
(*c*) (i) 0·75 m s^{-2}
(ii) 2·0 m s^{-2}
(*d*) Tibby had travelled 32 m and Skipper had travelled 27 m so Tibby was ahead.

Newton's Laws

Newtons Laws of Motion – Balanced and unbalanced forces

51. (*a*) There are no unbalanced forces acting on the ball so it remains at rest.
(*b*) There is an unbalanced force exerted by the snooker cue so the ball accelerates in the direction of the force.

52. Its shape, speed and direction of travel can change.

53. (*a*) Negative acceleration of the cyclist.
(*b*) Acceleration of the ball.
(*c*) Cushion changes shape.
(*d*) Negative acceleration of the ball.

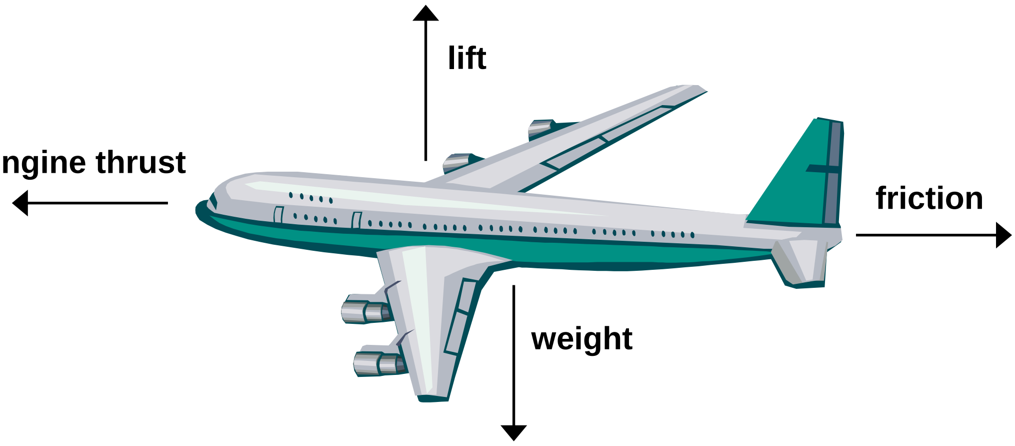
54. (*a*) Ball accelerates in direction of stretched elastic.
(*b*) No unbalanced force so no movement.
(*c*) (i) Balanced forces
(ii) Zero force.

55. (*a*) No.
(*b*) Yes, to the right.
(*c*) Yes, to the right.
(*d*) Yes, to the left.
(*e*) No.
(*f*) Yes, to the right.

56. (*a*) Balanced.
(*b*) Now unbalanced.
(*c*) (i) Balanced.
(ii) Air resistance, friction between tyres and road, friction in the engine and other moving parts.

57. (*a*) Friction due to water resistance.
(*b*) The dolphin will travel at a constant speed.

58



59. (*a*) The car will have a greater acceleration due to its smaller mass.
(*b*) The engine producing a larger force will give the car greater acceleration.

60. (*a*) The acceleration will decrease.
(*b*) The car will have greater acceleration.

61. (*a*) 20 N.
(*b*) 100 N
(*c*) 10 m s^{-2}
(*d*) 10 m s^{-2}
(*e*) 5 kg
(*f*) 50 kg

62. 25 N

63. 2400 N

64. 3 m s^{-2}

65. 60 kg

66. (*a*) 2000 N
(*b*) (i) Friction is increased.
(ii) Negative acceleration will be greater.

67. (*a*) 1000 N
(*b*) 0·5 m s^{-2}

68. 7 m s^{-2}

69. (*a*) 100 000 N
(*b*) 100 000 N

70. (*a*) (i) 500 N
(ii) 475 N
(*b*) To the left, towards the teachers.

Work Done, Force and Distance

71. work = force × distance in direction of force $E_w = F d$

72. (*a*) 5 J
(*b*) 2000 J
(*c*) 40 m
(*d*) 0·5 m
(*e*) 10 N
(*f*) 100 N

73. 6·3 m

74. 3 000 000 J

75. (*a*) (i) 50 m
(ii) Converted to heat energy by the brakes.
(*b*) –0·5 m s^{-2}

Weight and Gravity

76. Pupil A should state that weight is measured in newtons
Pupil B makes the correct statement.
Pupil C should state that mass is a measure of the amount of matter in an object.

77. 9·8 N kg^{-1}

78. weight = mass × gravitational field strength $w = m g$

79. (*a*) 9·8 N
(*b*) 4·9 N
(*c*) 39·2 N
(*d*) 1 kg
(*e*) 5 kg
(*f*) 3·06 kg

80. (*a*) Her mass is 50 kg.
(*b*) 490 N

81. 12 740 N

82. (*a*) 7·84 N
(*b*) 1·28 N

83. 5130 N

84. (*a*) It decreases.
(*b*) 11·25 N

85. (*a*) The gravitational field strength will decrease as the rocket moves away from the earth but will increase again as it approaches the Moon.
(*b*) The gravitational fields of the Earth and the Moon pull in opposite directions. The Moon's is much weaker so at a point nearer the Moon they will balance each other out.

Extension questions

86. (*a*) 644 N
(*b*) (i) 588 N
(ii) 1560 N
(*c*) 7 kg
(*d*) 56·5 N

Newton's Laws and Space Flight

87. (*a*) 1 460 000 kg
(*b*) (i) 29 400 000 N or 29 400 kN
(ii) 14 308 000 N
(iii) Unbalanced force = 15 092 000 N, acceleration = 10·34 m s^{-2}
(*c*) To reduce the mass of the shuttle as the rockets are no longer providing any thrust.
(*d*) (i) Air resistance and gravity.
(ii) The atmosphere gets thinner and gravitational field strength decreases.
(iii) The acceleration will increase.

88. (*a*) The exploding gunpowder pushes the cannonball forwards and the cannon backwards with the same force.
(*b*) The air escaping from the balloon is pushed backwards and an equal and opposite force pushes the balloon forwards.

89. The water is pushed downwards out of the rocket which causes an equal and opposite force on the rocket upwards.

90. Both the astronaut and the spaceship move backwards as there is an equal an opposite force on both no matter who pushed.

Free Fall and Terminal Velocity

91. (*a*) A represents force from engine and B represents air resistance and friction.
(*b*) The forces will be equal and opposite.
(*c*) Terminal.

92. (*a*) The heat generated by the friction with the air at high speed heats the outside of the capsule to a high temperature.
(*b*) Their maximum speed reached when all the forces are balanced and there is no acceleration.
(*c*) Parachutes are deployed to increase the amount of air resistance.

Extension Questions

93. (*a*) 10 m s^{-2}
(*b*) 545 m
(*c*) As there is now more air resistance, this slows down his rate of acceleration.
(*d*) 7·7 m s^{-2}

Projectiles

94. (*a*) Projectile path
(*b*) (i) None
(ii) Gravity
(*c*) As the ball travels forwards at a constant velocity it simultaneously accelerates downwards.

95. (*a*) (i) Equal distances.
(ii) Increasing distances.
(*b*) The ball has no unbalanced forces acting on it in the horizontal direction but there is an unbalanced force due to gravity acting in the vertical direction.

96. (*a*) 0 m s^{-1}.
(*b*) (i) Constant speed.
(ii) Acceleration.
(*c*) 5 s
(*d*) 5 s
(*e*) (i) 9·8 m s^{-1}
(ii) 49 m s^{-1}

97. (*a*) (i) 0 m s^{-1}
(ii) 49 m s^{-1}
(*b*) (i) 8 m s^{-1}
(ii) 8 m s^{-1}
(*c*) (i) 122·5 m
(ii) 40 m

Satellite motion

98. (*a*) Projectile
(*b*) (i) It does not affect it.
(ii) The cannonball takes longer to reach the Earth's surface.
(*c*) (i) Satellite motion.
(ii) The surface of the Earth is moving away from the cannonball as quickly as the cannonball descends towards the Earth.

99. (*a*) The period of the orbit.
(*b*) (i) It will take longer.
(ii) It will take less time.
(*c*) (i) A geostationary satellite.
(ii) Telecommunications, transmitting TV signals, weather observation.

Space exploration

100. (*a*) To explore the surface of Mars.
(*b*) The Mars Rover was able to photograph the surface of Mars. It was able to find evidence that there had once been liquid water on Mars.
(*c*) To send a manned mission to Mars.

101. (*a*) 60 years ago.
(*b*) Satellites are used to allow mobile phones to function and for the transmission of satellite broadcasts such as Sky television.
(*c*) There are many more employed in industries which are ‘spin-offs’ of space exploration.
(*d*) Satellites high above the Earth can accurately map the ground below.

Re-entry and Heat

102. (*a*) There is a lot of friction with the Earth’s atmosphere due to the high speed of the shuttle.
(*b*) It is covered in heat resistant tiles which are thicker on the underside where most heat is produced.

103. The edge of the wing will have become very hot and been so badly damaged that it caused the shuttle to break up.

104. (*a*) (i) It is turning from a solid into a liquid ie. melting.
(ii) It is turning from a liquid into a gas ie. vaporising.
(*b*) It is going into changing the state of the substance rather than increasing its temperature.
(*c*) Latent heat.

105. Heat energy = mass $\times$ latent heat

106. (*a*) Latent heat of fusion.
(*b*) Latent heat of vaporisation.

107. (*a*) $2{\cdot}24 \times 10^6$ J
(*b*) 167 000 J
(*c*) $3{\cdot}6 \times 10^6$ J kg^{-1}
(*d*) $1{\cdot}0 \times 10^6$ J kg^{-1}
(*e*) 20 kg
(*f*) 0·05 kg

108. (*a*) $10·02 \times 10^5$ J
(*b*) $67·8 \times 10^5$ J

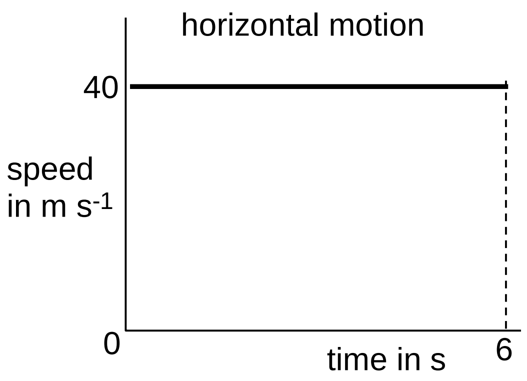
109. (*a*) Heat energy.
(*b*) Its high speed causes a lot of friction with the Earth's atmosphere.
(*c*) The heat energy is absorbed by the heat shield causing it to melt.

110. The astronaut needs to have an environment to supply him or her with a breathable atmosphere as space is a vacuum. The suit must also protect them from extremes of temperature and from cosmic radiation.

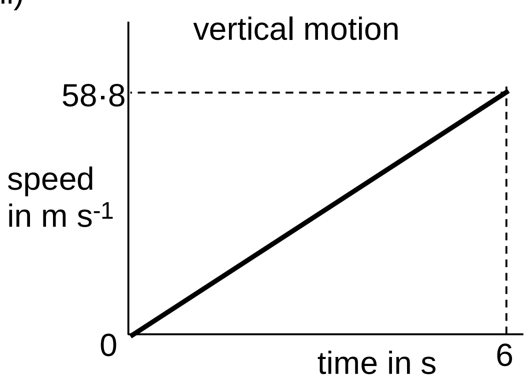
Extension Questions

111. (*a*) The satellite is in orbit at a fixed height above the Earth's surface.
(*b*) Geostationary satellite.
(*c*) (i) The pull of gravity is less.
(ii) The time taken to make one orbit will increase.

112. (*a*) (i) None
(ii) Gravity
(*b*)



(*c*) (i) 9·8 m s^{-2}
(ii) 58·8 m s^{-1}
(iii)



(*d*) Horizontal distance = 240 m, vertical distance = 176·4 m

113. (*a*) 0·7 s
(*b*) 3 m s^{-1}
(*c*) 29·4 m s^{-1}

114. (*a*) There is no atmosphere so fluids boil at lower temperatures and there are extremes of heat.
(*b*) (i) 720 J
(ii) 500 000 J.
(iii) The space debris contains much more kinetic energy.
(*c*) The temperature in space fluctuates through extremes of temperature and the human body has to be kept at a constant temperature.

Cosmology

The Universe

115. It is the distance that light will travel in one year.

116. $9{\cdot}46 \times 10^{15}$ m

117. $1{\cdot}53 \times 10^{11}$ m

118. 4·2 light years

119. 30 021 light years

120.

Term	***Definition***
(*a*) Solar system -	a star and its associated planets.
(*b*) Moon -	a body revolving around a planet.
(*c*) Planet -	a body revolving around a star.
(*d*) Sun -	the star at the centre of our solar system.
(*e*) Galaxy -	a grouping of solar systems.
(*f*) Universe -	all the matter that we know of.
(*g*) Star -	a ball of burning gas at the centre of a solar system.

121. The Big Bang tries to explain the beginning of the universe as we know it. It is a process of expansion in our universe that is still going on today and started with a very small concentration of matter at extremely high density and temperatures called a singularity. The dense mass contained only hydrogen and a small amount of helium. it began expanding rapidly outward. The first stars were probably formed when the universe was 200 million years old as matter began to form into stars and planets.

Evidence for the Big Bang theory:
Red shift – all objects in the universe are moving away from each other. Evidence for this is provided by the shift in the spectrum of distant stars towards the red end of the spectrum due to the Doppler effect.

Cosmic Microwave Background
The relatively uniform background radiation is the remains of energy created just after the Big Bang.

Quantity of Hydrogen and Helium in the universe
The composition of the universe has been measured and found to be along with 1% of the more interesting These are the values predicted by the big bang model.

Telescopes and waves
122.

Wave	***Detector***
(*a*) Visible light -	the eye or photographic film.
(*b*) X-rays -	photographic film.
(*c*) Radio -	aerial and radio receiver.
(*d*) Television -	aerial and television receiver
(*e*) Gamma radiation -	Geiger counter, photographic film.
(*f*) Infrared -	IR camera or film.
(*g*) Ultraviolet -	fluorescent material.
(*h*) Microwaves -	aerial and microwave receiver.

123. (*a*) A – radio waves
B - microwaves
C - infrared
D – X rays
(*b*) 3×10^8 m s^{-1}
(*c*) (i) Radio waves.
(ii) Gamma radiation.

124. (*a*) Radio waves
(*b*) It has a very large dish.
(*c*) There is no atmosphere to block or distort the images received.

125. (*a*) A - objective lens
B - light-tight tube
C - eyepiece lens
(*b*) The image will be brighter.

126. (*a*) It splits into its component colours or wavelengths.
(*b*) (i) Red, orange, yellow, green, blue, violet.
(ii) Violet
(*c*) (i) A continuous spectrum has every wavelength present. A line spectrum has only a number of wavelengths present.
(ii) The elements present in the star.

127. (*a*) (i) Red light.
(ii) Violet light
(*b*) The elements present in the star.

EXTENSION QUESTIONS

128. Helium and nitrogen.

129. (*a*) Light and other waves in the electromagnetic spectrum.
(*b*) 9·17 hours.
(*c*) 158 days
(*d*) Cosmic radiation, extremes of temperature and space debris and small meteorites.
(*e*) The Milky Way.
(*f*) (i) The distance light travels in one year.
(ii) 1×10^{12} m
(iii) 105 699 light years.
(*g*) This is impossible to say as it is constantly expanding.