Section A

1. B
2. B
3. D
4. D
5. C
6. C
7. B
8. C
9. C
10. C
11. A
12. A
13. C
14. D
15. B
16. C
17. B
18. B
19. B
20 .B

Section B

1. (a) (i) D and either lorry accelerates (forward) or resultant force is forward

(ii) air resistance or (air) drag or friction (between tyres and road)

(b) (i) from W = m x g

$$m = \frac{W}{g} = \frac{300\ 000}{10} = 30\ 000 \text{ kg}$$

(ii) from F = m x a

$$a = \frac{F}{m} = \frac{15000}{30000} = 0.5 \text{ m/s}^2$$

2. (a) difference in heights = 80 -20 = 60 cm

1 cm = 100 Pa
60 cm = 6000 Pa

(b) (i) same
(ii) decreases

(c) (i) $P = \frac{F}{A}$

(ii) F = W = weight

$P = \frac{W}{A}$ $W = P \times A$ = 6000 x 0.1 = 600 N

3. (a) for an object in equilibrium, the sum of the clockwise moments about any point equals the sum of the anticlockwise moments about the same point

(b) $F_1 \times d_1 = F_2 \times d_2$

$F_1 \times 20 = 4 \times 40$
$F_1 = 8$ N

(c) force exerted by pivot on metre rule is downwards = F_x

Rule in equilibrium = resultant force vertically is zero

Sum of upwards force = sum of downwards force

$8 = 1.2 + 4 + F_x$

$F_x = 2.8$ N

4. (a) 56 °C

(b) Q = ml

= 110 x 210 = 2.3 x 10^4 J

(c) (i) (wax) is solidifying or freezing

(ii) molecules come closer to form structure and loses potential energy. Latent heat is given out and The kinetic energy of molecules is unchanged as temperature is constant

5. (a) (i) E_p = mgh = 75 x 10 x 20 = 1.5 x 10^4 J

(ii) kinetic energy = potential energy

$\frac{1}{2}$ m v^2 = 1.5 x 10^4

$\frac{1}{2}$ x 75 x v^2 = 1.5 x 10^4

v = 20 m/s

(b) (G) potential and kinetic energy at the start and then

to elastic/strain/clear equivalent /EPE at end

6. (a) All three rays parallel to the principal axis

(b) (i) (speed) reduced or slows down

(ii) (speed) returns to original value/3.0 × 10^8 m / s

(c) (i) from v = f x λ

$$f = \frac{v}{\lambda} = \frac{3 \times 10^8}{6 \times 10^{-7}} = 5.0 \times 10^{14} \text{ Hz}$$

(ii) unchanged

7. (a) imaginary line that joins all identical (points / crests /troughs) on waves

(b) (i) decreases

(ii) decreases

(iii) unchanged

8. (a) correct normal by eye that is perpendicular at B
correct angle of incidence between candidate's normal and incident ray
correct angle of refraction marked between candidate's normal and BC

(b) due to change in speed or wavelength of light

(c) n = $\frac{\sin i}{\sin r}$

$$\sin r = \frac{\sin i}{n} = \frac{\sin 45}{1.5}$$

$$r = \sin^{-1}\left(\frac{\sin 45}{1.5}\right) = 28.1^0$$

(d) refracts less at first face
refraction at second face away from normal so that red ray and blue ray are diverging

(e) (i) angle of incidence is 0
or ray along normal/perpendicular to glass

(ii) angle of incidence/θ is larger than critical angle
total internal reflection occurs

(iii) draw reflected ray inside glass without any refraction

(iv) (eventually) light emerges (into air at Q)
or light refracts (out at Q)
or (weak) refracted ray appears

9. (a) pressure created at master piston is transmitted through the fluid to the slave piston. This pressure produces a force on the slave piston which causes the brake shoes rub against the drum.

(b) (i) P = F/A = 140/2.0

= 70 (N/cm^2)

(ii) F = P x A = 70 x 2.8 = 200 N

(iii) distance foot to pivot larger than piston to pivot
force × distance constant

c) (i) molecules hit against walls/piston

(ii) hit more often/more frequently
smaller volume or molecules closer/less space

(iii) $P_1V_1 = P_2V_2$

$1 \times 10^5 \times 6\ (\times 2) = P \times 4 \times (2)$

$P = 1.5 \times 10^5$ Pa

(d) air/bubbles compress/reduce in volume or brakes pushed further/spongy

Section C

1. (a) Table: correct d values

   70.0, 60.0, 50.0, 40.0, 30.0, 20.0, 10.0 in cm

   (b) (i) d against F (or vice versa) OR distance against force/force meter reading

   (ii) Straight line

   passing through origin

   (c) Would change force meter reading/change mass on rule

   (d) Check distance from bench is the same at two points

2. (a) 23 °C

   (b) Axes correctly labelled with quantity and unit x-axis = t/s and y-axis = $\theta/^0$C
   Suitable scales
   All plots correct to ½ small square
   Good line judgement
   Thin, continuous line

   (c) Two from:
   Room temperature/humidity/sun through window/air conditioning
   Draughts
   Initial water temperature

3. (a) Blocks parallel with ONE sphere completely between
   Rule correctly placed

   (b) (i) Line of sight perpendicular to scale
   Line of sight along bottom of meniscus

   (ii) 70 cm^3

   (iii) 0.53 cm^3, 2 or 3 significant figures, with unit

4. (a) any one from:
   - reference to how to determine the centre of the bob
   - measure to top of bob then add on half diameter measured with blocks and rule or callipers
   - measure to top and bottom of bob and average
   - reference to perpendicular viewing (reducing parallax)
   - rule parallel with/close to string/appropriate use of set-square

   (b) (i) t = 28.4

   (ii) T = 1.42 s

   (iii) reduce effect of errors in starting/stopping stopwatch

(c) statement to match results (expect no)
justification using results, including idea of difference is beyond limits of experimental uncertainty

(d) minimum of three more values
all values ≥ 20 cm and ≤ 300 cm, and three values are at least 10 cm apart