VICTORIA JUNIOR COLLEGE

SUGGESTED SOLUTIONS TO 2015 H1 P1 PHYSICS PRELIM EXAMS

1. The term $\dfrac{1}{e^{\left(\frac{hf}{kT}\right)}-1}$ is unitless.

Hence comparing units: $[(D^3)] = \dfrac{[R]\times[c^2]}{[h]}$

where [ ] represents "units of".

Since units of R are J s^{-1} m^{-2}/s^{-1}, units of c^2 are $m^2\,s^{-2}$ and units of h are J s, units of D^3 are s^{-3}. Hence D has unit s^{-1}.

Ans: B

2. The range of resultant forces possible is from 3 N to 13 N. Hence 2 N is impossible.

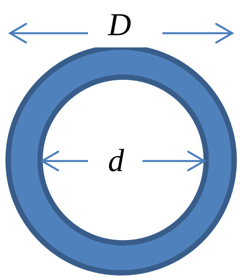
Ans: D

3. A liter is 1000 cm^3 or 10^{-3} m^3.
500 mL of water therefore corresponds to (500 x 10^{-3}) x 10^{-3} = 5 x 10^{-4} m^3 and a mass of 0.5 kg or 500 g, taking density of water to be 1000 kg m^{-3}. The molar mass of water is 18 g. Hence number of water molecules = $\dfrac{mass}{molar\ mass}\times N_A$

$= \dfrac{500}{18}\times 6.02\times 10^{23} \approx 10^{25}$

Ans: A

4. Let D and d be external and internal diameters of the ball respectively. Let t be the thickness of the wall of the ball.



The mean wall thickness is $t = \dfrac{1}{2}(D-d)$

$= \dfrac{1}{2}(95.0-87.0) = 4.0\text{ mm}$

$\Delta t = \dfrac{1}{2}(\Delta D + \Delta d) = 0.1\text{ mm}$

Hence the radius is 4.0 ± 0.1 mm.

Ans: C

5. Since the sandbag is moving upwards with the hot air balloon, there will be an initial upward velocity of 5.0 m s^{-1} immediately after release. It will continue moving upwards with a constant deceleration (decreasing velocity) until it reaches a maximum height, where its velocity is instantaneously at 0 m s^{-1} Thereafter, it will start to accelerate downwards (increasing velocity in the negative direction).

Ans: C

6. The vertical component of the velocity of the stone when it passes the edge of the cliff on its way down has the same magnitude as the velocity with which it is originally thrown upwards.

Using $s = ut + \dfrac{1}{2}at^2$, and taking downward direction as positive,

$s = (8.0\sin 58.0°)(1.5) + \dfrac{1}{2}(9.81)(1.5^2)$

$= 21.2\text{ m}$

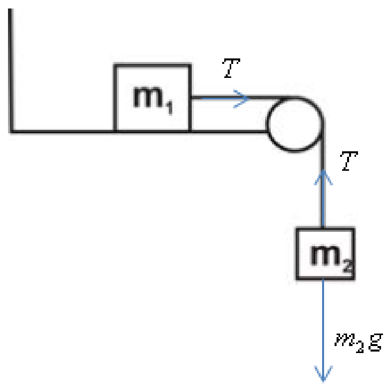
Ans: C

7. By Newton's Second Law,

$< F > = \dfrac{\Delta p}{\Delta t} = \dfrac{2.0-(-2.0)}{0.10}$ = **40 N**

Ans: D

8.



Let tension in string be T.
By N2L for mass m_2, we have
$m_2 g - T = m_2 a$ .....(1)
For mass m_1, we have $T = m_1 a$ ....(2)
Eliminating T,

$$a = \frac{m_2 g}{m_1 + m_2}$$

Ans: B

9. By Hooke's Law,

$$F = kx$$

$$(250 \times 10^{-3})(9.81) = (2.5 \text{x} 10^2) x$$

$$x = 9.81 \text{x} 10^{-3} \text{ m}$$

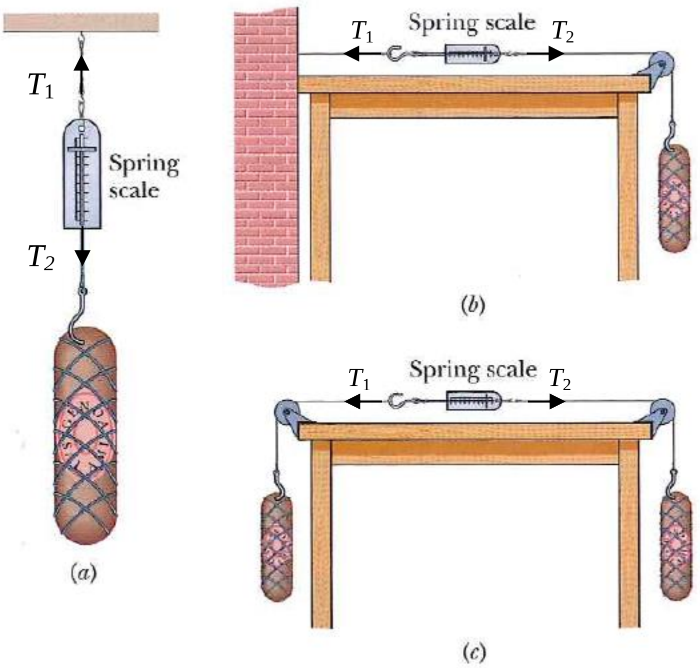
$$U = \frac{1}{2} k x^2$$

$$U = \frac{1}{2}(2.5\text{x}10^2)(9.81\text{x}10^{-3})^2$$

$$U = 1.20 \text{ x} 10^{-2} \text{ J}$$

Ans: A

10.



Looking at the diagram (a), T_2 has the magnitude of the weight of the load, and since the spring system is in equilibrium, T_1 will be equal to T_2. All 3 diagrams show T_1 and T_2 pulling on the spring balance in opposite directions and there is equilibrium in each case. Hence the spring balance will read the magnitude of T_2 = 100 N in all 3 cases.

Ans: D

11. Taking P to be the pivot,
sum of clockwise moments = sum of anti-clockwise moments

$$(2.0)(9.81)(0.40) + (2.0)(9.81)(0.50) = T_Q(0.90)$$

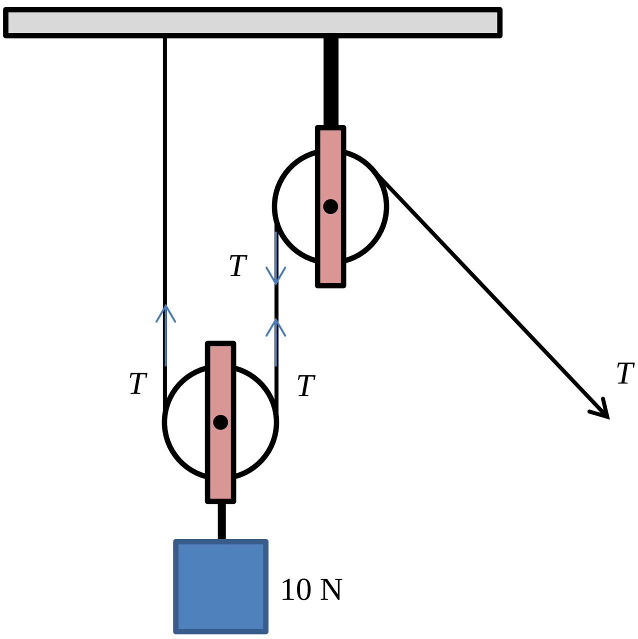
$$T_Q = 19.6 \text{ N upwards}$$

Ans: B

12. As Pressure = Force / Area,
the force acting on the bullet at any instant can be calculated by multiplying the pressure as shown by the graph by the cross-sectional area of the bullet.
The gain in KE of the bullet = work done on the bullet by the gas pressure
= area under pressure distance graph x cross-sectional area
$\frac{1}{2}mv^2 = [\ \frac{1}{2}(1.5 + 3.0) \times 10^8 \times 0.050 +$
$\frac{1}{2}(3.0 + 0.8) \times 10^8 \times 0.350\ ] \times 2.5 \times 10^{-5}$
$\frac{1}{2} \times 0.0040 \times v^2 = 1940$
v = **990 m s^{-1}**.

Ans: C

13.



As the speed of the load is constant,
$2T = 10$ and $T = 5$ N = constant.

In rising 1.0 m vertically, the work done on the load is $mgh = 10(1) = 10$ J.
Hence, the tension T (due to someone pulling on the rope) must cause the rope to move by 10/5 = 2.0 m

Ans: B

14. P will start to move upwards while Q will start to move *downwards* after this instant.

Ans: C

15. $\lambda = \frac{c}{f} = \frac{3\text{x}10^8}{10^{14}} = 3 \text{ x } 10^{-6}$
$= 30 \text{ x } 10^{-7}$ m

Ans: C

16. The sound generated by the vibrating string is a *progressive* longitudinal wave.

Ans: D

17. **Ans: B**

18. $R = \frac{\rho l}{A} = \frac{4\rho l}{\pi d^2}$
Hence resistance of P is 4 times that of Q.
From $I = \frac{V}{R}$ where V is the p.d. across both P and Q, current flowing through P is 4 times smaller than that flowing through Q, i.e. $I_Q = 4I_P$. Hence I_P is only $\frac{1}{5}$ of the total current.

Ans: A

19. Energy per unit charge across R is the potential difference across R.

Ans: B

20. The resistance of the conductor at a point in the I-V characteristic is given by
$R = \frac{V}{I} = \frac{V-0}{I-0}$
= reciprocal of the gradient of a line drawn from the origin of the I-V characteristic to the point in question, i.e. the smaller the gradient of this line, the greater the resistance.
Such a line has the least gradient for point A and hence the conductor has the greatest resistance at this point.

Ans: A

21. Current $I = 3.0 + (3.0 \text{ x } 2.0)/6.0$
= 4.0 A.
Total resistance of external circuit,
$R = 1.5 + (2.0 \text{ x } 6.0)/(2.0 + 6.0) = 3.0\ \Omega$.
Efficiency output of emf source, η, is given by
$\eta = \frac{IV}{IE} = 0.90$, where V is the terminal p.d. Thus, $E= V/0.90$
= (4.0 x 3.0)/0.90 = 13.3 V

Ans. C

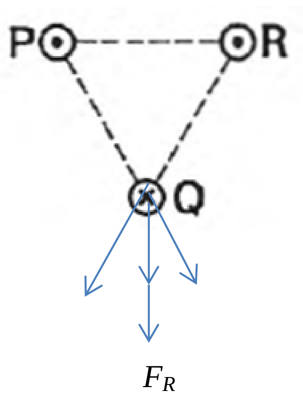
22. Current through the (5.0 + 5.0) kΩ branch = 2.0 x 10^{-4} A flowing in the direction from top to bottom Thus, V_1 =1.0 V. The current through the (2.0 + 3.0) kΩ branch = 4.0 x 10^{-4} A also flowing in the direction from top to bottom. Thus, V_2 =1.2 V. Hence, $V_2 - V_1$ = 1.2 – 1.0 = 0.2 V.

Ans. B

23. The setup has essentially two currents flowing the in the same direction. Hence there will be attractive forces between X and Y. The attractive forces acting between them constitute an action and reaction pair and are of the same magnitude.

Ans: D

24.



The forces acting on Q due to P and R are repulsive and are of the same magnitude as shown in figure. F_R is the resultant of the two forces.

Ans: C

25.Using FLH's rule and noting that the charge is positive, the deflecting force on charged particle is upward in the plane of the paper as it enters the B field.

Ans. D

26. From Einstein's equation $KE_{\max} = hf - \phi$, maximum kinetic energy is dependent only on work function ϕ of the metal and frequency f of incident light.

Ans: B

27.The minimum frequency for photoelectric emission is called the threshold frequency.

Ans: B

28. $V_s e = hf - \phi$ or

$$V_s = \left(\frac{h}{e}\right) f - \frac{\phi}{e} \text{ or}$$

$$y = \left(\frac{h}{e}\right) x - \frac{\phi}{e}$$

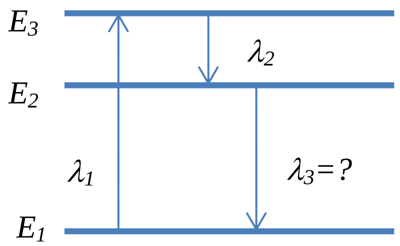
Ans D

29. $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$ where

$$E = \frac{1}{2} m v^2 = \frac{p^2}{2m}$$

Ans: D

30.



$$E_3 - E_1 = (E_3 - E_2) + (E_2 - E_1)$$

$$\frac{hc}{\lambda_1} = \frac{hc}{\lambda_2} + \frac{hc}{\lambda_3}$$

$$\frac{1}{\lambda_3} = \frac{1}{\lambda_1} - \frac{1}{\lambda_2} = \frac{\lambda_2 - \lambda_1}{\lambda_1 \lambda_2}$$

$$\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_2 - \lambda_1}$$

Ans: D