2016 Preliminary Examination H1 Paper 1 Solutions

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	**A**	**C**	**A**	**D**	**B**	**D**	**B**	**B**	**A**	**C**	**C**	**D**	**A**	**D**
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
C	**C**	**C**	**A**	**B**	**C**	**C**	**D**	**A**	**A**	**D**	**B**	**D**	**C**	**A**

1 **D** V_m = volume per unit mol
→ unit of b = unit of V_m = $m^3\ mol^{-1}$

Unit of $[a/V_m^2]$ = unit of P = Pa
→ Unit of a = Pa $(m^3\ mol^{-1})^2$ = Pa $m^6\ mol^{-2}$

2 **A** Average = (7.6 + 7.5 + 7.8 + 7.4 + 7.6) /5 = 7.6 cm.
True value given = 7.5 cm , so average value of 7.6 cm is accurate to within 0.1 cm.
The 5 values are not precise to within 0.1 cm as there is a spread of values from 7.4 cm to 7.8 cm.

3 **C** A: In the measurement of the diameter of a sphere, take more readings and finding the average value of these readings will help to reduce the ~~fractional uncertainty of the diameter.~~ (random error)
B: Plotting a graph of voltage and current readings for an ohmic conductor and using its gradient to find resistance will help to ~~eliminate~~ (reduce/minimize) random error.
D: Checking for zero error on a voltmeter before measuring voltage will help to ~~reduce random error~~ (eliminate systematic error).

4 **A**

$$g = \frac{4\pi^2 l}{T^2} = \frac{4\pi^2(0.500)}{(1.42)^2} = 9.789\ \mathrm{m\ s^{-2}}$$

$$\frac{\Delta g}{g} = \frac{\Delta l}{l} + 2\frac{\Delta T}{T}$$

$$\Delta g = \left[\frac{0.001}{0.500} + 2\left(\frac{0.02}{1.42}\right)\right] \mathrm{x} 9.789 = 0.295 = 0.3\ \mathrm{m\ s^{-2}}\ (\mathrm{to\ 1\ sf})$$

g = (9.8 ± 0.3) m s^{-2}

5 **D** Taking upwards as positive, since net force is weight downwards, by N2L, acceleration is constant g value, downwards (negative constant value)
At rebound, there is a sharp positive peak as there is sudden impulsive force acting upwards on the ball within a short time of impact
As the ball is moving upwards after rebound, the net force is still weight downwards
→ acceleration is still negative constant value.

6 **B** When body moving upwards, net force is downwards = W+ drag force = ma, deceleration a > g
When body is at maximum height, velocity = 0, net force is downwards = W; a = g
When body is moving downwards, net force is downwards = W – drag force = ma such that acceleration downwards a < g
So, value of acceleration downwards < value of deceleration upwards
→ time taken downwards > time taken upwards

7 **D** For X:

applying $v = u + a\,t$ in the vertical direction:

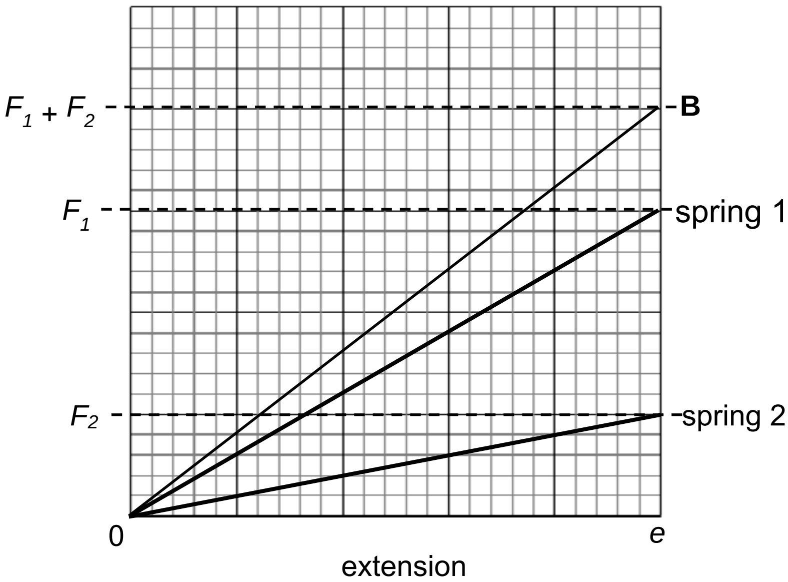
$0 = u \sin\theta - g\,t$ Hence $t = \dfrac{u\sin\theta}{g}$

Similarly for Y:

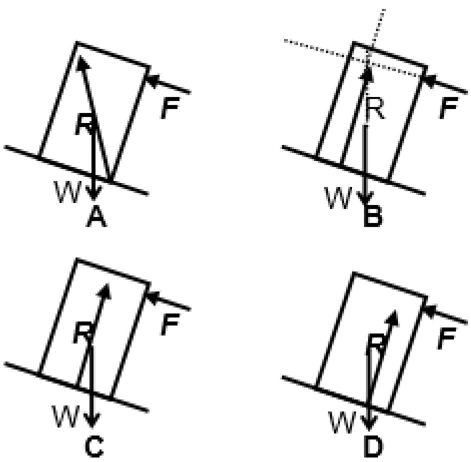
Time to reach max height = $\dfrac{(2u)\sin\theta}{g} = 2\,t$

Since horizontal velocity for Y is $2\,u\cos\theta$ (or 2 times that of X) and time taken for Y to reach max height is twice that for X, horizontal displacement of Y at max height is 4 times that of X.

8 **B** When joined in parallel, both springs would have the same extension, but the applied force would be shared between them. So if the extension is e, spring 1 would be supporting F_1 and spring 2 would be supporting F_1. The applied force is thus $(F_1 + F_2)$.



9 **B** The weight of the block has to be included.
Since there are three forces on the block, the forces should be concurrent.



10 **A** The net force is -mgsinθ is a constant. So the net force = rate of change of momentum = slope = constant

11 **C** Use relative speed of approach = relative speed of separation [6-1 = 2-(-3)], as well as conservation of ke.
The incorrect answer A also fulfils the relative speed equation, but because M is heavier, the system seems to have an increase in ke after the collision.

12 **C** Initially, when v=0, viscous force is zero. Since mg = ma, the initial acceleration is *g* for both masses.
Viscous force is proportional to speed v. At terminal speed,
mg = kv, if mass is large, terminal velocity is large.

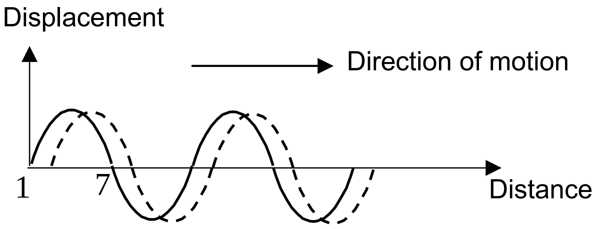
13 **D** Pressure P = hρg, so dP/dh = ρg = 1000x9.81 = 10^4 Pa m^{-1}

14 **A** at initial angle 45°, the initial horizontal velocity = vertical velocity, i.e. $u_x = u_y$.
at any instant G PE = mgh. Since h = $u_y t - 1/2\ gt^2$, so PE =mg($u_y t - 1/2\ gt^2$),
at any instant KE = ½ mv^2 = ½ m($v_x^2 + v_y^2$) and $v_y = u_y - gt$,
so KE decrease, then increase quadratically with t.
At maximum height, both KE and PE are equal at ½ mu_x^2

15 **D** By definition, work done by force F = force F x displacement in the direction of force z

16 **C** Power P = Force x distance/time = force x velocity

17 **C** Taking to the right to be +ve displacement,



At the next instant of time, particle 1 has –ve displacement (which means it is moving to the left) while particle 7 has +ve displacement (which means it is moving to the right)

18 **C** Period T of the wave = $\frac{1}{f} = \frac{1}{12.5} = 0.08\ s$
Since the wave is moving to the right, Q will be moving upwards in the next instant of time.
Hence, shortest time taken for Q to move to zero position =
$\frac{3}{8} \times T = \frac{3}{8} \times 0.08 = 0.03\ s$

19 **A** $I = ka^2$
$a' = a\cos 60^\circ = 0.50a$
$I' = k(0.50a)^2 = 0.25ka^2 = 0.25I$

20 **B** Using pythagoras theorem = path length L_2 D = $(40^2+9^2)^{½}$ = 41 m
Path difference between L_1 D and L_2 D = 41 – 40 =1 m
v = fλ
For 1st maximum, path difference = 1λ ⇒ λ = 1 m
330 = fλ = f(1)
f= 330 Hz

21 **C** Point X is a node. At one particular instant of time, particles on the left of X will move to the right while particles on the right of X will move to the left, producing a region of compression at X . At another instant of time, particles on the left of X will move to the left while particles on the right of X will move to the right, producing a region of rarefaction at X.

22 **C** Power = Energy/time = 120/2.0 = 60 W
A is wrong since current I=P/V = 60/120 = 0.5 A = 0.5 Cs^{-1}
B is wrong since 120 V means 120 J delivered for each Coulomb of charge
D is wrong. It should be 60 J per second when current is 2.0 A

23 **D** The resistance at 1.2 V is 0.4 x 10^3 Ω, not 0.4 Ω
The trend of the graph shows that as V increases, current I increases sharply, so ratio V/I decreases

24 **A** When pd is applied across BD,
combined resistance across BD, R_{BD} = 20/3 Ω
When pd is applied across AB,
combined resistance in branches BD and BCD = 20/2 = 10 Ω
Add to branch AD which is in series = 10 + 10 = 20 Ω
Combined resistance across AB = $(1/10 + 1/20)^{-1}$ = 20/3 Ω

This is same as R_{BD} in the previous case.
Since power to circuit, $P = V^2/R$ ➔ $P_{BD} = P_{AB}$

25 **A** Original distribution of resistance across the two loops in the circuit is R/2 to R/2 i.e. 1:1. The new distribution is R to R/2 i.e. 2:1.
Due to the new distribution of resistance, the voltage across X will increase (2/3 V) and the voltage across Y and Z will decrease (1/3 V). Since current is V / R, and R is constant, the increase in voltage across X will cause an increase in current through X while the decrease in voltage across Y and Z will cause a decrease in current through Y & Z.

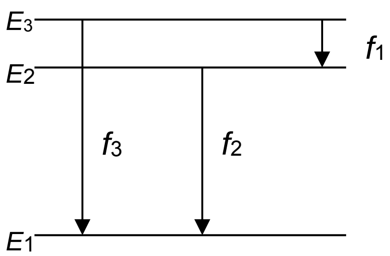
26 **D** Using LHR, for the magnetic force on the wire to be downwards, the magnetic field must be towards the right.

27 **B** Use the Right Hand Grip for current in wire X to find the magnetic field at P and Q, then use the LHR to find the forces at P and Q.

28 **D** $hf = \phi + K$ ……(1)
$h(2f) = \phi + K'$ ……(2)

$2(\phi + K) = \phi + K'$
$K' = \phi + 2K$
$> 2K$

29 **C**



$E_3 - E_1 = h f_3$; $E_3 - E_2 = h f_1$; $E_2 - E_1 = h f_2$
$E_3 - E_1 = (E_3 - E_2) + (E_2 - E_1)$
$h f_3 = h f_1 + h f_2$

30 **A** Decrease in electron's KE is transferred to the atom, exciting it. This is subsequently released as a photon when the atom de-excites.
Thus $\frac{1}{2} m(u^2 - v^2) = hf$.