Question 1

(a) $[\ v\ ] = \text{ms}^{-1}$

while $[\ \rho\ ] = \text{kg m}^{-3}$

$[\ E\ ] = \text{kg m}^{-1}\text{s}^{-2}$ ……………. [B1]

$[\ E/\rho\ ]^2 = \left[\ \dfrac{\text{kg m}^{-1}\text{s}^{-2}}{\text{kg m}^{-3}}\ \right] = \text{m}^4\text{s}^{-4}$ ……………… [M1]

since unit of v is different from the unit of $(E/\rho)^2$, hence this equation is not homogenous… [A1]

(b) (i)

$$V = \frac{\pi}{4} d^2 h$$

$$\frac{\Delta V}{V} = \frac{2\Delta d}{d} + \frac{\Delta h}{h}$$

$$= \frac{2(1)}{16} + \frac{1}{28}$$ ……………… [C1]

$$= 0.1607$$

$$= 16\%$$ ……………. [A1]

percentage uncertainty = ……16 %…. [2]

(b) (ii)

The student may use vernier caliper instead of ruler to measure both diameter and height since the dimension is small ……………..[B1]

OR:

the vernier caliper has smaller uncertainty of measurement / is more precise ……..

OR [B1]

This can reduce the percentage of uncertainty of volume …………….. [B1]…… [2]

Question 2

(a) (i)
$E_k = \frac{1}{2} mv^2$
$= 0.5 \times 70 \times 20^2$…….[C1]
= 14 000 J………….[A1]

total kinetic energy = …14000……J [2]

(a) (ii)
$E_p = mg\Delta h$
$= 70 \times 9.81 \times 10$……[C1]
= 6867 J……..[A1]

loss of gravitational potential energy = …6900 ….. [2]

(a) (iii)

Gain of KE > loss of PE………[B1]

Because cyclist does work……..[B1]

Energy is wasted (on the cyclist and cycle) due to the air resistance / friction or transferred to thermal or heat ……….[B1] [3]

(b) (i)

$s = \frac{1}{2}(u + v)t$

$t = \frac{2 \times 150}{20}$ ……….[C1]

= 15 s ………[A1]

time = … …15…s [2]

(b) (ii)

$F = ma$

$= 70 \times \left(\frac{0-20}{15}\right)$ ……….[C1]

= -93.3 N ……………….[A1]

force = …93.3……N [2]

Question 3

(a) (i)

T = ¼ mg

= ¼ × 22000 × 9.81.......[C1]

= 5.40×10^4 N…...........[A1]

tension = …5.4×10^4….N [2]

(a) (ii)

Moment = F x r

= 22000 × 9.81 × 32….......[C1]

= 6.9×10^6 Nm................[A1]…. unit [A1]

moment = …6.9×10^6 Nm. [3]

(a) (iii)

The counterweight [B1] provides a sufficiently large anticlockwise moment [B1] (about Q) or moment in opposite direction (to that of the container to prevent the crane toppling clockwise)

OR

Left hand pillar [B1] pulls down and provide anticlockwise moment [B1] [2]

(b) (i)

Tensile stress = F/A

$= \frac{5.4 \times 10^4}{3.8 \times 10^{-4}}$ ....[C1]

= 1.42×10^8 Pa ....[A1] . unit [A1]

stress = 1.42×10^8 Pa.…[3]

(b) (ii)

Extension = $\frac{FL}{AE}$ ....[C1]

$= \frac{1.42 \times 10^8 \times 25}{2.1 \times 10^{11}}$ ....[C1]

= 17 mm…[C1] [3]

Question 4

(a)

meter show highest reading when the probe pass the antinode (where the amplitude is greatest), ...[B1]

and reading decreases till the probe reach node where the displacement is zero (or minimum) ....[B1] … [2]

(b)

$\lambda = 2 \times 15\,\text{mm} = 0.030$ m ....[C1]

$f = \dfrac{c}{\lambda} = \dfrac{3.0 \times 10^8}{0.030} = 1.0 \times 10^{10}$ Hz ....[A1]

frequency = …1.0×10^{10}…....Hz [2]

(c)

(f increase, λ decrease) the distance between consecutive zero reading is closer (Or is reduced by half Or 7.5 mm)……………… ....[B1 … [1]

Question 5

(a) electrical force acting upwards to overcome the weight by gravity---[M1]

so, the particle is positively charge ....[A1] …… [2]

(b) (i)

$E = \dfrac{V}{d} = \dfrac{300}{0.0062}$ ....[B1]

$= 4.839 \times 10^4$ Vm^{-1}.......[A1]

field strength = ……4.84×10^4…..NC^{-1} [2]

(b) (ii)

$mg = qE$ ....[B1]

$q = \dfrac{mg}{E} = \dfrac{5.1 \times 10^{-15} \times 9.81}{4.839 \times 10^4}$ ....[B1]

$= 1.03 \times 10^{-18}$ ....[A1]

charge = …1.03×10^{-18}…….. C [3]

(c) increase electric field strength........[B1] by decreasing the separation between two plates ....[B1]
OR increase electric field strength ....[B1] by increasing the p.d. across two plates ....[B1]

Question 6

(a)

For 2 parallel 400 Ω resistors, $R_T = \left(\frac{1}{400} + \frac{1}{400}\right)^{-1}$ = 200Ω……………[B1]

R_T = 25 Ω + 200Ω
= 225 Ω …………………[A1]

total resistance =……225….Ω [2]

(b) (i) $P = V^2/R$
$2.0 = V^2 / 200$
$V = \sqrt{2 \times 200}$ …………..[B1]
V = 20 V…………..A[1]

p.d. = …..20………… V [2]

(b) (ii) I = V/R
= 20/ 400
= 0.05 A ....[B1]
∴ current = 2 x 0.05 = 0.10 A ………....[A1]

current = ………0.10…… A [2]

.

(b) (iii)
p.d across 25 Ω resistor = 25 x 0.10 = 2.5 V ....[B1]
max applied p.d = 20 +2.5 = 22.5 V ....[A1] .d.= ………22.5…. V [2]

Question 7

(a) (i)
nucleus emits α- or β- particles and/or γ-rays ……….[B1]
to become more stable ………………….. [B1] .... [2]

(a) (ii)
decay unaffected by environmental changes ………………….. [M1]

such as temperature, pressure etc. (one e.g. is sufficient) …………… [A1]mmm............. [2]

(b) (i) Complete the nuclear equation for the α -decay of a Americium -241 nucleus.

$$^{241}_{95}Am \rightarrow {}^{237}_{93}Np + \ldots\ldots\ldots \; {}^{4}_{2}He$$ …….[A1] [2]

…….[A1]

(ii) The unstable radioactive phosphorus isotopes have several modes of decay. Phosphorus-32 decays by emission of a beta particle (an electron). Fig. 7.1 shows the position of Phosphorus-32 ($^{32}_{15}P$) on a diagram in which nucleon number (mass number) A is plotted against proton number (atomic number) Z.
On Fig. 7.1, show this decay by labelling the position of the daughter product as D.
[1]

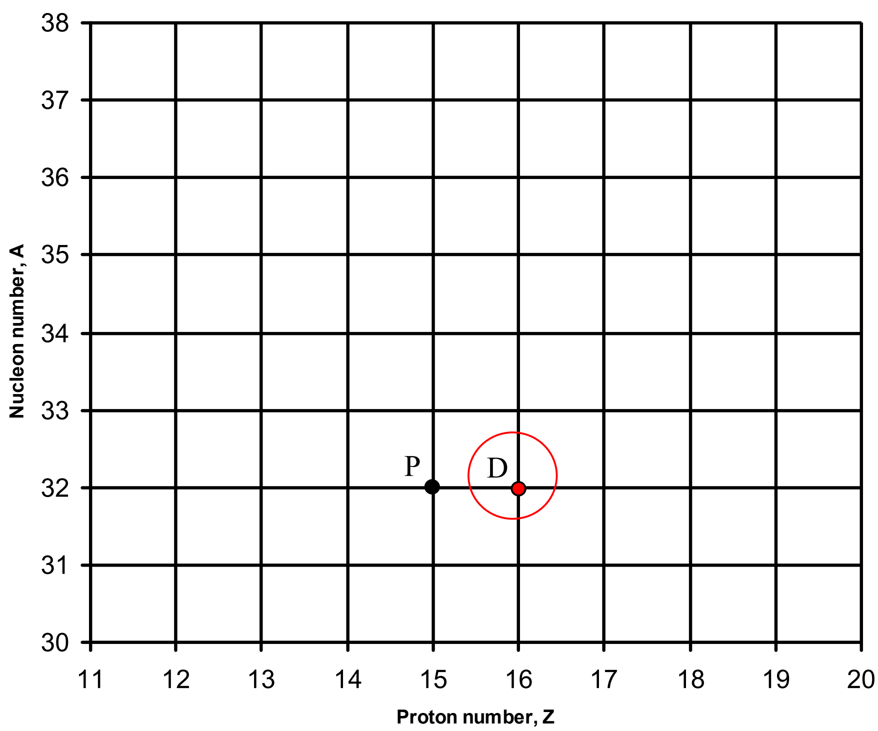

Fig. 7.1

…….[A1]