M1. (a) Structure of P:

$$CH_3$$
 CH_2CH_3 $CH = CH_2$ (1)

Structures of **Q** and **R**:

$$CH_3$$
 and CH_3 $C=C$ CH_3 CH_3 $C=C$ $CH(CH_3)_2$ $CH(CH_3)_2$

Q and R in any order

(b) (i) Racemic mixture: equal mixture of optical isomers / enantiomers

OR in explanation

Explanation: planar (>C=O) (1) attack from either side is equally likely (1)

(ii) Reagent S: HCN or (KCN / HCl or H₂SO₄) (1)

Compound
$$T$$
:

 $CH_3CH_2 - C - CH_3$
 CN
 CH_3
 CH_3
 $C = C$
 CH_3
 CH_3
 $C = C$
 CH_3
 CH_3
 $C = C$
 CH_3
 CN
 CH_3

[9]

3

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(ii) total moles =
$$0.86 + 0.43 + 0.085 = 1.375$$
 (1)
 \therefore mole fraction of H₂ = $\frac{0.86}{1.375} = 0.625$ (1)
(0.62 - 0.63)
Conseq on (i)

(iii) pp = mole fractⁿ × total P (1)
=
$$0.625 \times 1.75 \times 10^4$$

= 1.09×10^4 (kPa) (1)
or $1.1(0)$
Ignore units
Conseq on (ii)

5

(b) (i)
$$K_p = \frac{P_{CH30H}}{P^2_{H_2} \times P_{co}}$$
 (1)
Penalise []

(ii)
$$K_{p} = \frac{2710}{(12300)^{2} \times (7550)} = 2.37 (2.4) \times 10^{-9}$$
 (1)
 $OR \ 2.37 \times 10^{-15}$

Units: kPa⁻² (1)
 $or \ Pa^{-2}$

$$CH_3 - \overset{CH_3}{\overset{\bullet}{\underset{CH_3}{\vdash}}} \overset{O}{\underset{OCH_3}{\lor}} \qquad \text{allow}$$
(c) Isomer **E**:
$$(CH_3) \overset{OCOOCH_1}{\underset{CH_3}{\lor}} \qquad (CH_3) \overset{OCOOCH_2}{\underset{OCH_3}{\lor}} \qquad (CH_3) \overset{OCOOCH_3}{\underset{OCOOCH_3}{\lor}} \qquad (CH_3) \overset{OCOOCH_3}{\underset{OCOOCH_3}{\smile}} \qquad (CH_3) \overset{O$$

[10]

3

2